

THE 2015 GO-OUTSIDE-AND-PLAY ISSUE

Popular Mechanics

50

THRILLING
ADVENTURES
IN ALL 50
STATES

HOW YOUR WORLD WORKS

STAY UP ALL
NIGHT WITH
JIM CANTORE

AMERICA'S
WEATHERMAN
PAGE 67

GET READY FOR AN
ADVENTURE

✕
FLY A PLANE

✕
SOAR TO SPACE
IN A
HELIUM BALLOON

✕
DEEP SEA DIVE IN A
THRUSTER SUIT

✕
RIDE A ZIPLINE
ROLLER COASTER

✕
CHASE A TORNADO

HIT THE ROAD IN THE
NEW ALUMINUM
(ALUMINUM?)

FORD F-150.

HOW TOUGH IS IT?
WE FOUND OUT.

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AND WHEN
YOU'RE DONE:
HOW TO PRINT
ALL THOSE
PHOTOS STUCK IN
YOUR PHONE

PAGE 49



AMERICA'S
MAGAZINE
SINCE 1902

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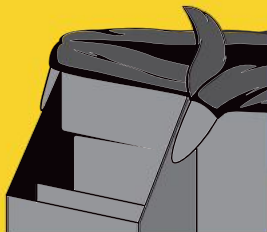


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CINCHES KEEP BAG FROM FALLING IN



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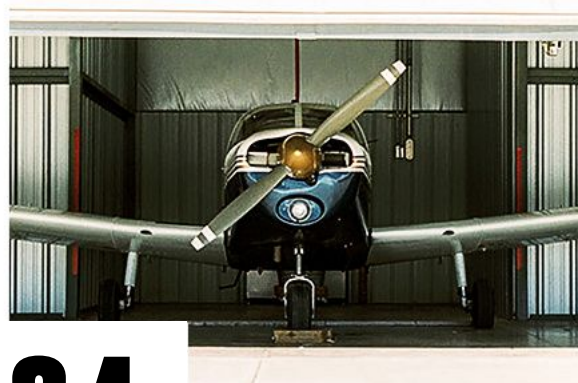
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The first entry in a four-part series: A man who is afraid to fly attempts to learn how.

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THE READERS PAGE

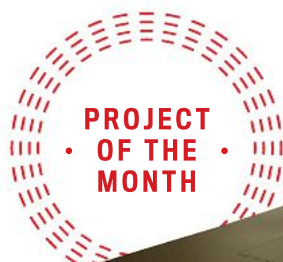


ONE TIP ON TWO-CYCLE ENGINES If your two-cycle engine sputters when you try to accelerate it, the culprit is likely a spark arrestor screen, which can become clogged with carbon. Clean it by removing the screen assembly from the muffler and burning off the accumulated carbon residue with a propane torch.
— **DANIEL JONES, ALLENTON, MICHIGAN**



THE FINISHED PRODUCT:
The Roland G. Murphy 801 A

While our profile of the Last American Watchmaker (March) detailed the making of Roland G. Murphy Watch Company timepieces, many of you wanted to see a completed timepiece. Herein, the RGM 801 A, made in Lancaster County, Pennsylvania.



A SPACE-SAVING CONFERENCE ROOM TABLE FROM A YOUNG WELDER

Brad Allen's cousin runs a garbage management consultancy—they help big companies reduce the expense of their trash contracts. What's it got to do with a table? When they moved to a converted warehouse office, they enlisted Brad to weld new furniture for the space. That included creating a table that could comfortably seat the team without taking up the entirety of their tiny conference room. So Brad, who's 27 and works in his day job as a fabricator for a metal shop while keeping his own space in Ramona, California, got creative with it. The chairs are built in to the table's framework, set on casters, and pivot in and out from underneath the table. He welded the 9½-foot-long piece out of cold-rolled 16-gauge 1½-inch steel tubing. Into the 16-gauge sheet-metal top, he carved out a set of storage hatches that open and close thanks to repurposed piano hinges. A local upholsterer helped him fashion the stool tops out of leather, and the paint job is autobody paint usually reserved for Jeeps. Just five years out of welding school, he's producing the work of a seasoned veteran of the trade. We'll continue to expect great things.

A REMINDER

We give \$100 for reader projects that we publish, and \$50 for original reader tips that we run. You can send both to editor@popularmechanics.com.

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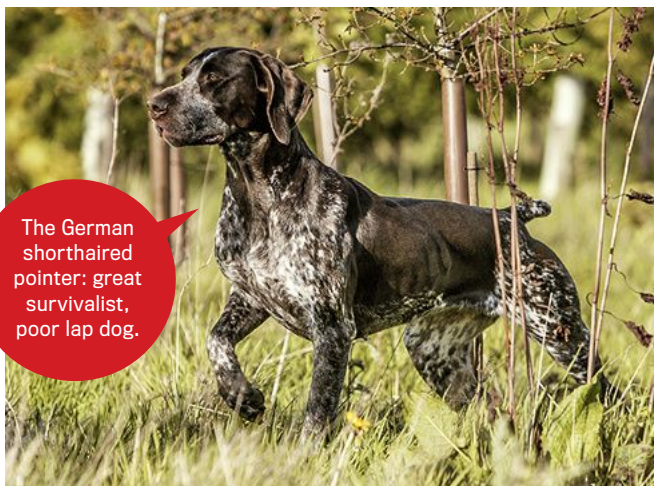
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LETTERS



WE COUNTED ON THERE NOT BEING MUCH PUMPKIN PIE DURING THE APOCALYPSE

Your survival story ("The Casual Man's Guide to Survival," March) notes that German shorthaired pointers are the best dogs to own. As a past owner, I have to agree. Ours was a medium-small male but as strong and athletic a dog as I have ever seen. He could jump four feet up onto my pool deck, run down woodchucks in the open, and pull my 6-year-old daughter through the snow. The only caution I would offer: This breed requires endless physical activity. I don't think we ever tired him out until he was 13 years old. He almost lost his life one Thanksgiving morning when he ate the freshly baked pumpkin pie my wife had put in the garage to cool.



BOB FOLEY

Mansfield, Massachusetts

WHO NEEDS A GUN WHEN YOU'VE GOT A GERMAN SHORTHAIRED POINTER?

I was amazed that in sixteen pages of survival gear and techniques by experts, rangers, special operations forces, and outdoorsmen ("The Casual Man's Guide to Survival," March), you made no mention of the most basic and American of survival gear: a gun.

RICH KOCH

New Milford, New Jersey

I just read your survival guide and I was struck by the failure to mention a firearm of any kind. When I

worked in Alaska as a newspaper editor, everyone I knew who ventured into dangerous territory carried a firearm. Aside from hunting game and providing protection, gun cartridges can be broken down and the gunpowder used as a fire starter.

JACK KNEECE

Peak, South Carolina

BUT HOW MANY DIFFERENT VERSIONS OF "PASSWORD123" HAVE YOU GOT?

I'm in full support of online security, but proposing to involve eyes takes it too far. Advanced technology like Myris ("Your Next Password: Your Eyeball," March) seems exciting, but I fear any long-term damage it may cause to my eyes. Having glasses myself, I would much rather rely on a typed password than trust a machine that scans a sensitive part of my anatomy. After all, I have only one pair.

PAVEL KHASANOV

Mississauga, Ontario

PRAISE FOR PRINT

It was refreshing to read something about the newspaper industry that talks about what we really do ("The Daily Miracle," March). Thank you for not quoting whining journalists complaining about our industry. Rather, you communicated the energy, power, and magnetism of print. When I finished the last word I yelled out, "Newspapers!"

ROBB REEVES

Hesston, Kansas

Publisher of The Ledger, The Hesston Record, and The Harvey County Independent newspapers

LETTER OF THE MONTH

As a mother of two teenage boys, I enjoy your magazine very much. All men and women should know how to fix anything, grill up a juicy steak, and defend their families when necessary. Both of my boys read the magazine cover to cover, and I do as well. Thank you for being an antidote to a pop culture that encourages whining, laziness, and passive living via electronics.

LEAH CESSNA

Cat Spring, Texas

Letters to the editor can be emailed to editor@popularmechanics.com. Include your full name and address. Letters may be edited for length and clarity. **CUSTOMER SERVICE/SUBSCRIPTIONS online:** service.popularmechanics.com, **email:** popcustserv@cdsfulfillment.com, **mail:** Popular Mechanics, P.O. Box 6000, Harlan, IA 51593, **subscribe:** subscribe.popularmechanics.com.

FROM THE EDITOR



How We Get Around

My F-150 delivered the workbench that is now taking up residence at our offices. Learn how to build it in the next issue.

purchase a large piece of furniture.

Having been an F-150 person, I was particularly interested when Ford announced plans to build the flagship model of its best-selling truck series, and the best-selling truck in America for the past thirty-eight years, out of aluminum. A lot of stories have been written about this, but none that does what automotive editor Ezra Dyer did: He hauled a two-and-a-half-ton roll of aluminum from the metal works that produced it to the factory where it would turn into the body of an F-150. It's an epic odyssey, and it begins on page 54.

On the subject of transportation, we have a treat for you this month: a beautiful story by Joshua Ferris, one of the most acclaimed novelists of his generation. Last summer I asked Josh if he would be willing to learn how to fly an airplane and write about the experience for Popular Mechanics. For some reason, he said okay. The first installment of his story, which will run over our next four issues, begins on page 84. Like the F-150, the Piper he flew is more than a mode of transportation. It can become a part of your life and change the way you see the world. In the F-150 the world is something to be conquered. In an airplane the world is something to be left behind, even for just a while. Machines can be useful that way. I hope you enjoy both stories, and the rest of this very adventurous issue.

RYAN D'AGOSTINO
EDITOR IN CHIEF

ONE OTHER THING: We made a mistake in our last issue. For the past few months, Popular Mechanics has been supporting a remarkable effort called the Esquire Mentoring Initiative. Created by Esquire magazine (also owned by our parent company, Hearst), the initiative aims to create 100,000 new mentors—positive male role models for young boys—in the next five years. Our support has consisted mainly of running advertisements urging men to take part (which you can do at mentoring.esquire.com). But last month, due to an error in our production system, an ad that was intended to run in Esquire instead ran in Popular Mechanics. It featured a profane word that was inappropriate for our audience. We deeply regret this mistake, and I apologize. We won't be running the ad again.

PopularMechanics
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CALENDAR

MAY
2015

What our editors are doing this month. And what you ought to be.

● - David Howard, executive editor

● - Jacqueline Detwiler, senior editor

● - Alexander George, associate editor

● - You

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
					Summer movie season kicks off early with <i>Avengers: Age of Ultron</i> .	Tuning up my Bianchi San Jose for tomorrow's TD Five Boro Bike Tour around New York City.
3	4	5	6		8	9
The TD Five Boro Bike Tour. Forty miles of urban streets without a car in sight.					Find a beater Kawasaki KLR650 motorcycle and take it on a trip north.	Get out the pole trimmer and trim back everything that touches the house.
10	11	12	13	14	15	16
Mother's Day. Find the kids and make something for her.				Re-watch all three Mad Max movies before seeing the new one tomorrow.	Charlize Theron and Tom Hardy predict a bleak future in <i>Mad Max: Fury Road</i> .	My Southern parents are in town, so I'm making a five-gallon pot of jambalaya.
17	18	19	20	21	22	23
Throw the kayaks in Little Lehigh Creek in Pennsylvania while the water's high.		Take polyester resin and sandpaper to fix my longboard's dings.			Disney and George Clooney predict a much brighter future in <i>Tomorrowland</i> .	Memorial Day weekend kicks off salmon-grilling season.
24	25	26	27		29	30
Finally staining my pine bed frame so it matches the rest of the furniture.	Memorial Day	Catch the 2015 Code Conference. Last year Sergey Brin unveiled Google's self-driving car.			Two loud, glorious hours of collapsing infrastructure in <i>San Andreas</i> .	Will likely still be explaining my Apple Watch to strangers.
31						
We're renovating our multiroom basement. Here's hoping the floor under the pool table is done by the end of May.						



THE ROAD TO PICKUP TRUCK GLORY IS PAVED WITH DOUGHNUTS

Automotive editor Ezra Dyer drove the new F-150 from Davenport, Iowa, where aluminum for the new truck is produced, to Dearborn, Michigan, where it's finally put together (see page 54)—a 430-odd-mile route of unremarkable freeway but for one proud detail: Between the two factories there is arguably the greatest succession of independent doughnut shops in America. Each of these five spots is worth stopping in for a cruller or old-fashioned glazed.

WEST

EAST

Donuts & More
1717 Brady Street,
Davenport,
Iowa

Geneseo Donut Inc.
215 N. State Street,
Geneseo,
Illinois

Munster Donuts
8314 Calumet Avenue,
Munster,
Indiana

Sweetwater's Donut Mill
2138 South Sprinkle,
Kalamazoo,
Michigan

Donutville U.S.A.
14829 Ford Road,
Dearborn,
Michigan

Two simple steps.



Clean. Then **coat** to keep headlights clear for up to a year.
meguiars.com



CONTESTS!



Mike's son Tyler, who grew up in his dad's shop, is going into mechanical engineering.



THE MOST POPULAR MECHANIC IN AMERICA: MEET MIKE BESSO

Of the hundreds of nominations we received in our search for America's Most Popular Mechanic, only a few had multiple submissions made in their honor. And none stirred more passion and enthusiasm than Mike Besso, mechanic and proprietor of Main Street Automotive in Little Falls, New Jersey. It was the stories of Mike and his work that earned him the title of our first ever Most Popular Mechanic. Besso has been at it since he was 20, and Mike has been operating his two-bay shop for the past twenty years. One of his customers told us Mike has exclusively performed the preventative maintenance of all twenty cars his family has owned in the past fifteen years. Another customer detailed Mike's detective work in finding a faulty passenger-door sensor that had caused the car's lights to stay on and the battery to die. They wrote in to tout Mike's honesty and his ability to tell people what truly needs immediate attention and what can wait. And when a cash-strapped customer came in with an emergency repair, Besso let him pay a few days after the work.

Congratulations, Mike. The people, your people, have spoken.

THE RUNNERS-UP

TWO MORE MECHANICS WHO ARE ALSO PRETTY POPULAR.

BRIAN KANE

AUTO ADVISORS
Springfield, New Hampshire

A customer's telling anecdote: "He is the one who will come to your house and help load your snow tires into the car because you discovered a bat in one of them and now you are too scared to go near them."

LOUIE PEJNOVIC

AUTOBAHN SERVICE CENTRE
Copley, Ohio

A customer's telling anecdote: "When a transmission problem confounded my dealership's service center, Louie accurately diagnosed a speedometer-sensor problem. No one else had even looked there."

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We are pioneers.

Our mornings, our nights and the waking hours in between —
this is when we discover what we can achieve.

We are determined to grow and build and cultivate
the life of our dreams. Because this is our ground.

Our opportunity. Our responsibility.

Our life to lead.

We are Kubota.



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For Earth, For Life
Kubota

HOW YOUR WORLD WORKS

Sensors in the 1.2-pound Samsung Gear VR combine with accelerometers in your smartphone to make virtual movement feel real.

MY WEEK IN VIRTUAL REALITY

With the recent launch of Samsung Gear VR, virtual reality can finally be brought home. But do you want it?

BY ALEXANDER GEORGE



✓ **STUPID OR** ☐ **AMAZING?**

< **COOLPEDS BRIEFCASE ELECTRIC SCOOTER:** Luggage you can ride, depending on your self-respect.

THE COCKPIT OF A JET FIGHTER, ANGKOR WAT, A PAUL MCCARTNEY CONCERT—I visited all of them without wearing pants. Those weren't my first experiences with virtual reality. I'd tested the Oculus Rift at tech conventions, and recently I explored a Volvo that wasn't on the road yet. (For Ezra Dyer's take on VR in a Volvo, turn to page 45.) But I never got to bring virtual reality home and try it from my couch. Samsung Gear VR (\$200) gave me that opportunity.

The device requires a Samsung S6 or Galaxy Note 4 phone, headphones, and, if you want to take full advantage of the games, a \$60 controller. (Also important: a swivel chair.) The phone slides into a compartment of the headset, where two lenses magnify its image to fill your field of view. You control a cursor by moving your head, and click to access programs through a touch panel over your right temple.

Although VR has been around for decades, mostly in arcades, the at-home product is still nascent. All you can really watch is short content. But there is some variety, and I was determined to experience everything VR could do.

Within the first few days I'd been through all the safari videos and dune-buggy ride-alongs in the Oculus Store (an app accessed through the headset), but the sensation of all of them is so stunning that I wanted everyone

I knew to try it. Showing my mom a 360-degree photo of Petra, Jordan, a city she visited decades ago, made her want to travel again. One friend bemoaned a future where everyone will wear these things. Another asked about the Runtastic VR workout app and was disappointed to discover that the headset didn't stay fastened during a burpee.

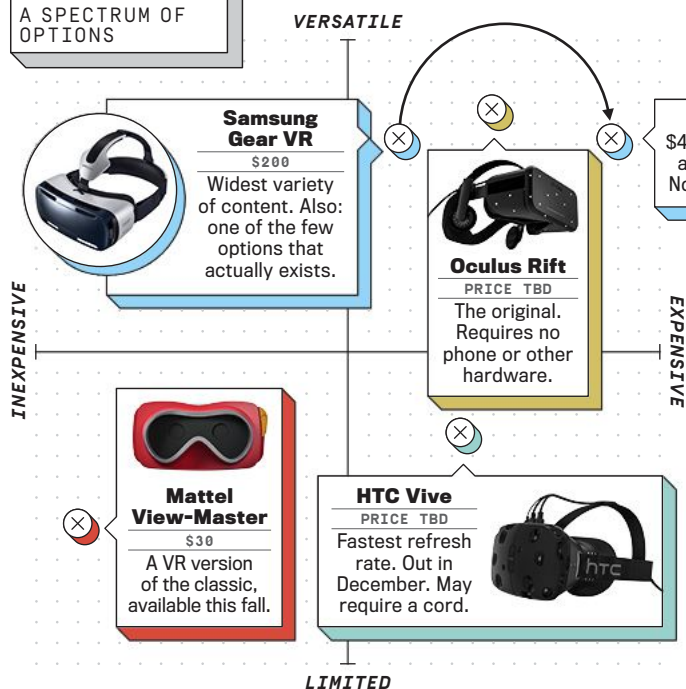
I wanted to try creating my own experience, so I found a panorama app (360Cities), photographed the Popular Mechanics offices, and loaded it onto the Note's SD card. I was astounded when it actually worked. I could look around our headquarters, albeit with a warped ceiling and floor where the camera stretched the photograph. It wasn't high quality, but strapping a VR-capable camera to my surfboard and reliving a thrilling wave feels imminent.

Right now, however, where the technology really shines is in movies. Plain old 2D movies. Netflix doesn't work on the Gear VR, so finding a compatible movie meant using a file converter of dubious legality. I ripped versions of *Enter the Void*, *The Red Balloon*, and clips from *2001: A Space Odyssey*, then had to transfer them to the Note and the Oculus Cinema app via the SD. The app doesn't do much—it adds a layer of digitized seats in front of you and makes the movie look like it's projected on a huge screen. But that's all I needed. Each movie stirred up everything I love about being in a theater. The trippy and exhilarating opening credits to *Enter the Void* made me shiver, especially when I looked to the side and saw the red velvet chairs reflecting the screen's flicker. The best part is that distractions aren't an option. I can't be tempted to catch up on Instagram or return emails during a lull in the action. Inside the Gear VR, you're forced to do nothing but watch the movie, something many of us have forgotten how to do.

It's only going to get better from here. Oculus is working with Pixar alums to produce immersive films within the year—an entirely new medium in which you're not just watching a movie but living it. And with Jaunt and Bubl, two 360-degree-camera makers, you'll soon be able to make your own immersive films too. The only unsolvable issue is how weird it will always feel to take the helmet off—a little like walking after running on a treadmill or jumping on the ground after using a trampoline. But coming back to reality has never been easy.

VIRTUAL REALITY

A SPECTRUM OF OPTIONS



+



MICROSOFT HOLOLENS



EPSON MOVERIO BT-200

THE OTHER REALITY: AUGMENTED

Virtual reality completely immerses your vision, while augmented reality overlays digital images on it. Although Google Glass was discontinued, Microsoft's new HoloLens and other recent products are taking AR in a more useful direction. As part of a trial, engineers at Lockheed Martin are using \$700 glasses made by Epson to perform maintenance on F-35 fighter jets with virtual assistance. Look at a brake component and you see step-by-step animated instructions. No need to double-check the manual.

#ForTheAdventure



FOR THE RIDE



Take it from Bear, all adventures begin with preparation.

Become one of four lucky riders to WIN the training of a lifetime with Triumph Motorcycles and MotoMark1 off-road academy this fall.

Four days. Four Tigers. Four riders.

Contest details at ForTheAdventure.com

NEW TIGER



NOW YOU KNOW: The real difference between IndyCar and Formula One is that IndyCars race primarily in the U.S., and Formula One is global. It's like Premier League and Major League Soccer: same basic thing, different fanaticism. Also, only IndyCars race on oval tracks.

UNDER THE HOOD OF AN INDYCAR

IndyCar engines must weigh at least 248 pounds, and the car at least 1,570. So that's exactly what teams aim for and not an ounce more. We spoke with two of the men most responsible for the 2.2-liter twin-turbocharged Chevy V-6 that 2014 IndyCar Series champion Will Power will drive in the Indy 500 on May 24: Chris Berube (IndyCar Series Chevrolet program manager) and Ron Ruzewski (technical director for Team Penske). They explained how they get 675 horsepower from a car that's half the weight of a Mini Cooper S. — KEVIN DUPZYK

1. STARTER

This is where it would be if IndyCars had starters. The pit crew uses an external electric motor to crank the engine. One downside: If the car stalls, the driver can't restart it.

2. EXHAUST

To reduce weight, IndyCars have short exhaust pipes, no catalytic converters, and no mufflers.

3. STRUCTURE

The engine is a com-

ponent of the chassis, with a load-bearing block and cam covers. It literally holds the car together. The gearbox and suspension bolt to the back of the engine, and the driver compartment bolts to the front.

4. FUEL INJECTION

Most fuel-injected cars use nozzles to spray fuel into intake ports outside the combustion chamber, while some performance cars inject fuel straight

into the chamber. To give Power's IndyCar the massive amount of fuel it needs, his engine does both.

5. LUBRICATION

Traditional cars collect oil in the oil pan and pump it into the engine, but a race car moves fast enough that, with that setup, the oil would slosh around, preventing it from reaching the pump. Instead, a dry-sump system pumps oil to a separate

reservoir that keeps it constantly in reach.

6. PISTONS

The pistons are handmade to exacting, highly confidential specifications. Because racers look for every advantage they can get, Power's team can't share more.

7. COOLING

Scoops on the sides capture air to cool the engine. If the car sits for much longer than the eight to ten seconds of an average pitstop, it can overheat.

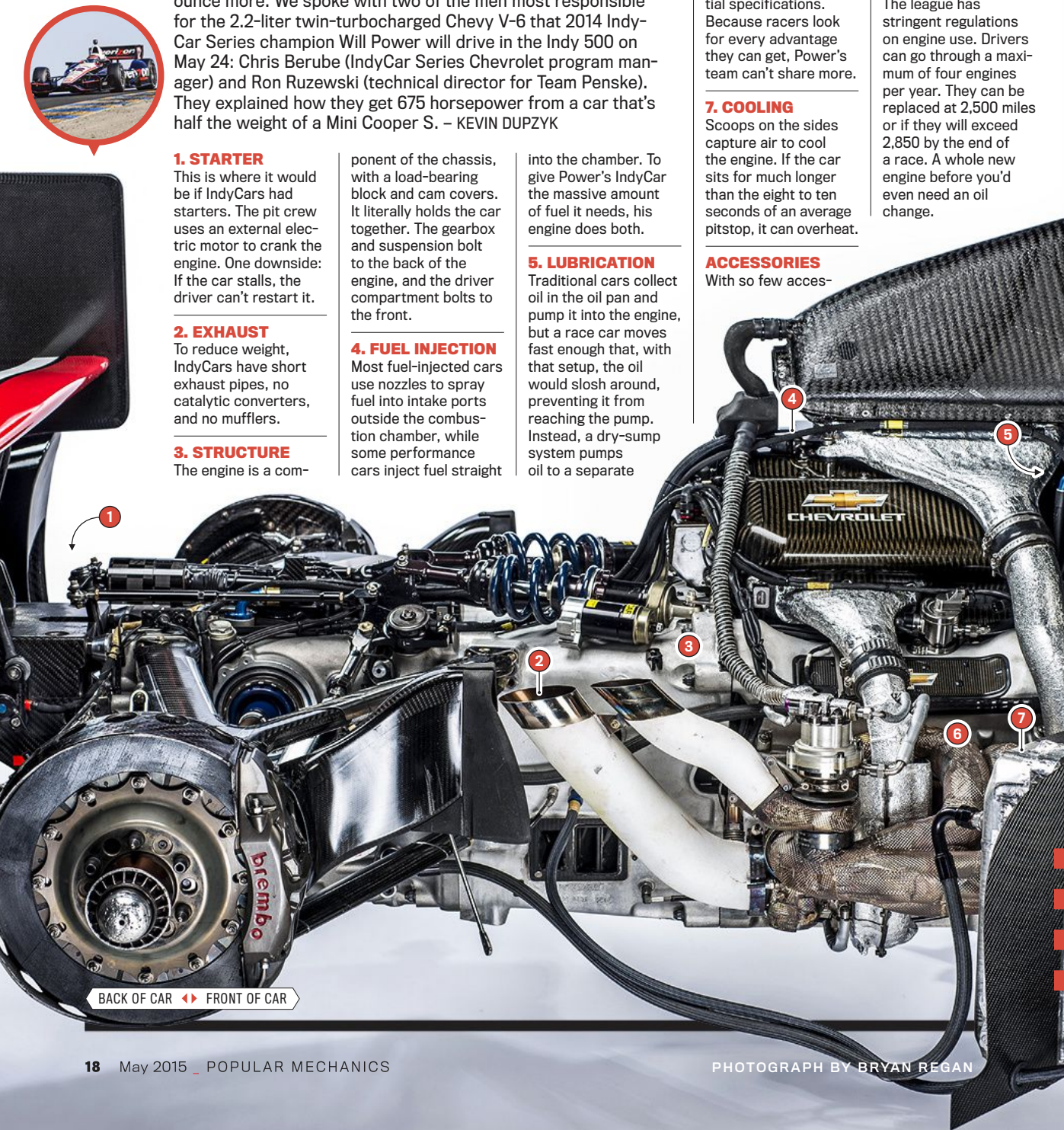
sories, there's no accessory drivebelt. Things like oil pumps are powered directly by the engine.

LIFE SPAN

The league has stringent regulations on engine use. Drivers can go through a maximum of four engines per year. They can be replaced at 2,500 miles or if they will exceed 2,850 by the end of a race. A whole new engine before you'd even need an oil change.

ACCESSORIES

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AMERICA'S CONTRACTOR

Bob Vila first appeared on TV in 1979, as host of *This Old House*. Over three decades he helped countless families renovate and rebuild, often while wearing plaid. It's been nine years since his last new TV show aired, which made us wonder what he's up to. We called him in Florida to check in. — MATT GOULET

POPULAR MECHANICS: When you started out, you were the only one doing home projects on TV. Today there are entire networks devoted to the idea. It must be nice to see the effects of your legacy like that.

BOB VILA: I try to avoid thinking about myself in terms of legacy. I'm alive and well and not looking at my career as being anywhere near over. But I am often accused of having invented reality television, which is an interesting point. What we were doing in 1979 was in a real house, with real people and real carpenters, plumbers, and electricians. There were real messes and real problems. Unfortunately, a lot of reality television today no longer focuses on the instructional or educational but, rather, on kind of the common, miserable, mundane problems of common, miserable, mundane people. I don't watch much of it.

PM: You don't like reality TV at all?

BV: A lot of the shows offer valuable information . . .

PM: But it's not how you did it.

BV: Look at *Extreme Makeover: Home Edition*. That program took the formula and crossbred it with the soap opera. Instructional television has been taken to all sorts of areas. As long as it's entertaining and not misinforming, more power to them.

PM: What's different about the way we work on our homes now compared with thirty years ago?

BV: Energy efficiency is at the top of the list. Could you give me one second?

[Vila puts down the phone for a few minutes.]

I'm sorry. I've got some home improvement going on! I have a landscape team doing some minor stuff, and I looked out the window and saw that I needed to mention a couple of things. So, your last question?

PM: We were talking about the different focus of today's projects.

BV: People are renovating with a different lifestyle in mind. They're seeking to create spaces that are informal and more expansive. The kitchen is more open to the dining area and to the playroom. The other areas of interest now are energy conservation and modern communication technology.

PM: The Internet of Things has really taken off.

BV: I like the fact that when I open the door of my new dryer, it will tell me to make sure I clean the lint



"I am often accused of having invented reality television, which is an interesting point."

filter. And I like the idea of security systems that call me up to let me know that their batteries need replacing. The more these systems self-diagnose and communicate, the easier it is to manage your household.

PM: Do you get stopped a lot? Can Bob Vila safely go to the hardware store without being bothered?

BV: I go anywhere I wanna go. Of course you're less recognizable

when your hair turns gray. At dinner parties somebody might start an interview process about their project, but that's fine.

PM: Does it feel good seeing every home-renovation host on TV dress like you? You defined that look.

BV: Isn't that funny? I was a contractor in Boston in the seventies, and that's the way I dressed. Jeans, plaid shirt, and a down vest. That's just the way I was.

PM: Is that how you dress now?

BV: Well, I wear a fleece vest occasionally, and I've got a closetful of plaid shirts, and—actually I have one on right now. But here in Florida, I dress a little more tidy.

PM: And the beard?

BV: I keep it trim.

HANDYMEN AND THEIR SIGNATURE TRAITS



BOB VILA,
beard



TOM SILVA,
accent



ROY UNDERHILL,
mustache



TY PENNINGTON,
bed head



MIKE HOLMES,
indignation

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THE REBIRTH OF HARD CIDER

Across America, artisans are reviving the libation that fortified our forefathers. This is your guide to enjoying it.

BY FRANCINE MAROUKIAN



AT ITS CORE, HARD CIDER is an agricultural product, an alchemical alliance between the apple and the land where it grows, shaped by the maker's skill. Unlike beer, cider is not made from grain, so it does not require brewing. Made with fruit, like wine, it only ferments. And because it ferments, craft ciders—those made with local orchard apples—have terroir, or a regional fingerprint reflecting variables of climate, soil, terrain, and tradition. For colonists, particularly in early New England and mid-Atlantic settlements, hard cider was a link to their British heritage and everyday way of life. Our early apples, cultivated from European trees, were not meant for eating out of hand. They were “spitters,” bitter tannic apples intended for preservation, particularly in the form of fermented cider—the only safe, bacteria-free daily beverage at the time.

Because apples are heterozygotes, their seeds do not breed true: An apple that grows from a seed will be nothing like the apple it came from. Instead, stem grafting is typically used to reproduce apples. A budding apple-tree shoot



THE EXPERT
Max Kuller, wine director, Doi Moi and Estadio restaurants, Washington, D.C.

is inserted into the stock of another tree already rooted in the soil.

The wide variety of apples in developing America was due in large part to early ecologist John Chapman, known as Johnny Appleseed, who traveled west planting orchards with seeds collected from cider mills. As a member of the Swedenborgian Church, Chapman believed that stem grafting was unnatural, so he practiced seed propagation, with each seed producing a different variety that adapted to regional conditions, making them distinctly different from Old World stock.

But by the early nineteenth

century, hard cider had lost its importance, a trend intensified by the temperance movement as farmers were pressured to clear their cider orchards in favor of growing the table apples we know today. Practical inventions also intervened. Sanitary waterworks and the bottle cap made new drinks like Coca-Cola possible. The pasteurization process, the milking machine, and the refrigerated box-car made milk more readily available as well. Cultural changes such as industrialization and urbanization also drew immigrants from other parts of Europe, including a significant German population who built breweries as the heart of



FIVE MUST-TRY REGIONAL HARD CIDERS

THE CIDER

ROYAL PIPPIN
8.5% alcohol*

THE MAKER

Albemarle Ciderworks, North Garden, Virginia



*by volume

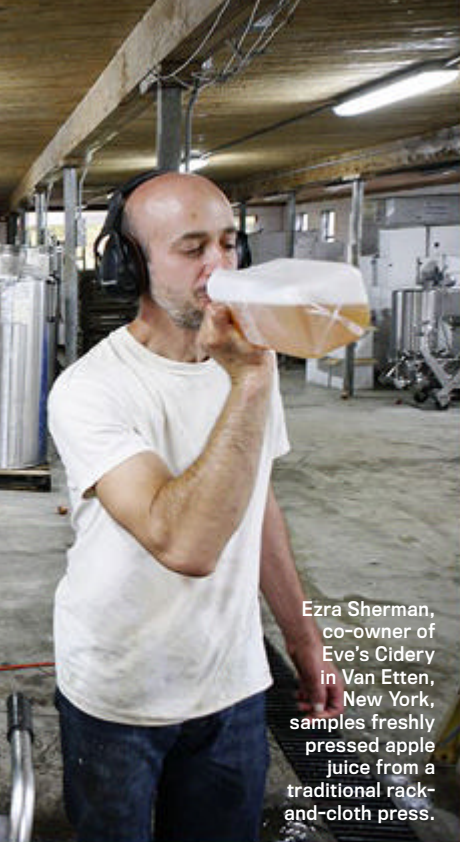
▶ A multigenerational project that grew out of the family farm, this single-varietal cider lets the classic American Newtown Pippin apple stand alone when it comes to flavor, without added flavors or blending.

FARMGATE
8% alcohol

Millstone Cellars, Monkton, Maryland



▶ Small-batch fermenting allows Millstone to be wildly experimental, aging natural-yeast ciders in oak barrels, like this bone-dry cider made with seven domestic heirloom apple varieties.



Ezra Sherman, co-owner of Eve's Cidery in Van Etten, New York, samples freshly pressed apple juice from a traditional rack-and-cloth press.

their neighborhoods. It was simply the end of the cider era.

Over the past several decades, renewed interest in America's agricultural heritage and heirloom pome fruits like apples and pears have boosted the taste for hard cider. According to the Beer Institute, national sales of hard cider grew by about 68 percent in 2012. Sure, the big dogs of macro cider lap up most of the credit. But by exploring the historical character of craft cider and introducing their own specialty variations, it's the orchardists and small producers who are reclaiming traditional cider in true American style.

MAKE IT

THE BASICS OF MAKING HARD CIDER

There are endless variations, but, in general, the cider-making process follows this formula.



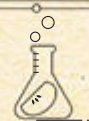
THE APPLES

Cider apples are divided into categories according to proportion of acidity and bitter-tasting tannins: sweet, bittersweet, sharp, and bitter-sharp. First allowed to soften to develop flavors and increase sugars, cider apples are then washed, sorted, and processed whole. Some are suited for single-varietal cider, mostly heirloom apples with the ideal ratio of tannins, acidity, and sugar. Other ciders require blending apples to balance flavors. This blending, which can be done at any stage, is the maker's skill at work.



THE GRIND AND PRESS

The apples are milled or ground into a fine pulp called pomace, collected into sieves such as mesh envelopes or trays, and stacked in a press. The presses vary in construction, from historical hand- or horse-turned screw presses all the way to modern hydraulic versions. After the free-flowing juice is released, compression continues to extract juice until the pomace is dry. Traditionally, this dry pomace "cake" was steeped in water to make ciderkin, the low-alcohol cider that colonial children drank.



THE FERMENTATION

The juice is transferred to a container (often a double-jacket stainless-steel vat) and fermented with yeast (either occurring naturally from the tannins in the apple skins, or a cultivated strain, such as wine yeast) that converts the sugar into ethanol and carbon dioxide, which escapes via an airlock on the fermentation container. The fermented liquid is then filtered—commercial cider is typically pasteurized—to remove yeast and apple particulates. Finally, it's transferred to the bottling stage, which varies from maker to maker.

A FEW NOTES ON TASTING

TASTE IT

The natural fruitiness of hard cider makes it a good partner for food that already marries well with apples, but it also enhances complex cuisine that skews pungent and spicy, like many Thai dishes. Because cider is fermented from fruit, you can deductively taste it like wine. And like wine grapes, fermented cider apples give off the impression of a multitude of other fruits as well.



There's a line connecting the appearance and the aroma of the cider to how it will present itself on the palate. Not to say craft cider can't surprise you, but, usually, if you can smell it, you will taste it.



If the cider is clear, with the solids filtered out, expect a more elegant taste and a fresh, fruit-forward aroma with traces of citrus (lemon, grapefruit) or even more aromatic tropical fruits (pineapple).



If the cider is cloudy, with particulates left from minimal processing, expect a more rustic experience, trading dominant fresh fruit and floral notes for a funkier, earthier, yeastier, organic aroma.

PERRY PEAR 8% alcohol

Eve's Cidery,
Van Etten,
New York



This semidry pear cider uses 60 percent traditional English cider-pear varieties and 40 percent Bartlett. A secondary, in-bottle fermentation, identical to the Champagne process, supplies its elegantly fizzy nature.

KINGSTON BLACK 8.5% alcohol

Farnum Hill,
Lebanon, New
Hampshire



Another single varietal, made with the distinctive bitter-sharp Kingston Black apple, presents perfect balance and impressive complexity. From an orchard growing heirloom cider varieties since the eighties.

HEIRLOOM BLEND ICE CIDER 10% alcohol

Eden Ice
Cider,
Newport,
Vermont



Made by freezing freshly pressed juice outdoors to concentrate sugars, natural sweet ice cider is a Canadian creation now embraced in Vermont by Eden, the first U.S. cider maker with a federally approved ice-cider label.

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Q

DO MAGNETS GO BAD? IF SO, HOW?

A MAGNETS DO GO BAD, USUALLY AS A RESULT OF CHILDHOOD abuse or deprivation. It's a sad state of affairs—but you can help. In return for your \$50 donation, we'll send you this jaunty Save the Magnets beach tote.

But seriously, folks . . . magnets do lose their oomph. To understand why, let's look at what makes a magnet a magnet. Take any old piece of iron. Inside are particles known as magnetic domains. In their natural state these particles are magnetically charged, but they're arrayed randomly, pulling in so many different directions at once that they effectively cancel each other out. Stick your iron in a strong magnetic field generated by something like a solenoid (an electrified coiled wire) and the magnetic domains will align and pull in the same direction. Now you've got yourself a magnet.

The thing is, this alignment forces the magnetic domains into a higher energy state, which (per the second law of thermodynamics) they don't like at all. Give them half an excuse (or, to use the scientific lingo, a catalyst) and they'll randomize themselves back into relaxation mode, just like the rest of us. One catalyst is simply time. Wait long enough and any magnet will fail. These days, though, long enough is a couple of hundred years, so this isn't a big worry. Another catalyst is heat. Heat a magnet sufficiently and it'll go back to plain old metal. Yet another threat is exposure to a more powerful magnetic field, which can yank the domains back out of alignment. Finally, there's shock. Drop a magnet repeatedly, or pound on it enough with a hammer, and you can jar the domains from their singular orientation. Delicate flowers, these magnets.

Does putting a piece of toilet paper on the seat do anything to protect you from germs?

You'd do just as well to burn a pile of sacrificial owl feathers or chant in Mycenaean Greek before mounting the commode. Or maybe you could slather your backside with a nice marine-grade wood varnish. Whatever makes you feel better. Any benefit derived from a toilet seat swaddled in bum wad is strictly psychological.

Toilet paper is both porous and absorbent, two qualities that more or less guarantee any unseemly or infectious microbes lurking on the seat will find a ready vector straight to your skin. The good news is that your skin, unlike TP, is neither porous nor absorbent, and effectively keeps bacteria and viruses out of your body. Not that we're suggesting this (necessarily), but you could drop trou, settle down on a nice, comfy heap of *E. coli*, and watch the full director's cut of *Apocalypse Now* without becoming ill. That's because most of the bathroom-borne nasties we face—things that cause what we will delicately term gastrointestinal upset—enter our bodies through our mouths, which is why hand washing is so important. You touch, say, the flush handle, which happens to be contaminated, then bite your nails or toss back a handful of cocktail peanuts and you might as well stay in the can because, brother, you're going to need it.



If you're worried about herpes, say, or other sexually transmitted infections, you can also rest easy on the throne. Experts agree these are spread only through prolonged skin-to-skin contact, not butt-to-seat contact, and, in any event, can't survive very long outside human hosts. You should be fine.

Is there a reason for the dearth of quality toasters?

At last—a question of true import. As it happens, there are several reasons virtually all modern toasters are lousy, and we'll get to those. First, though, let's solve your problem. You want a brawny bread browner built for the long haul? Get yourself a vintage Toastmaster 1B14 and thank us between bites of crisp, buttered breakfast perfection.

The 1B14 is “absolutely hands down the best toaster,” says Eric Murrell of the Toaster Collectors Association (a real thing). More than 7 million 1B14s were manufactured between 1947 and 1961, a.k.a. the Golden Age of Toast. “They're easy to find, they're not usually that expensive, and the doggone things work,” says Murrell, who, as the owner of more than 300 toasters, knows whereof he speaks.

So why can't modern toasters compete? Blame the American consumer, whose demand for ever-cheaper appliances has led to ever-cheaper materials and manufacturing methods. Compounding the problem is that folks have come to accept today's feeble toasters as disposable commodities with all the soul of a plastic spork. The final issue is maintenance—specifically, nobody does any. If people bothered to dump the crumbs out every once in a while, their toasters might last a little longer. Not much longer, mind you, but a little. Take care of a 1B14, on the other hand, and you'll be set for decades. “My sister, she lives in Alaska,” Murrell says. “She bought a secondhand 1B14 in 1969 and used it right up until, I think, about 2009.” A used toaster that lasts forty years? In Alaska? What are you waiting for?

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INSIDE:

MICROWAVING
IN THE
MODERN AGE
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A DRILL IN BITS
AND PIECES
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•

ITTY-BITTY
SHOP VACS
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SKILLS

The **Warn PullzAll** is a battery-powered winch that weighs eighteen pounds but can pull or lift up to a half-ton.

REMOVING THE BACKYARD COLOSSUS

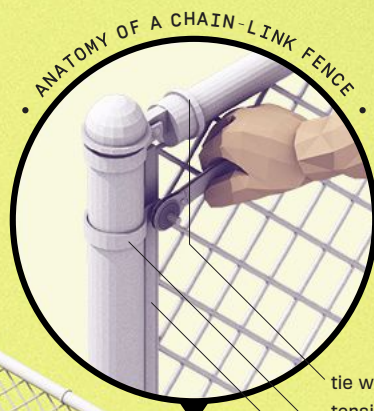
The chain-link fence, the slab of asphalt, that huge boulder. This spring, it's finally time to rid your property of eyesores.

BY ROY
BERENDSOHN

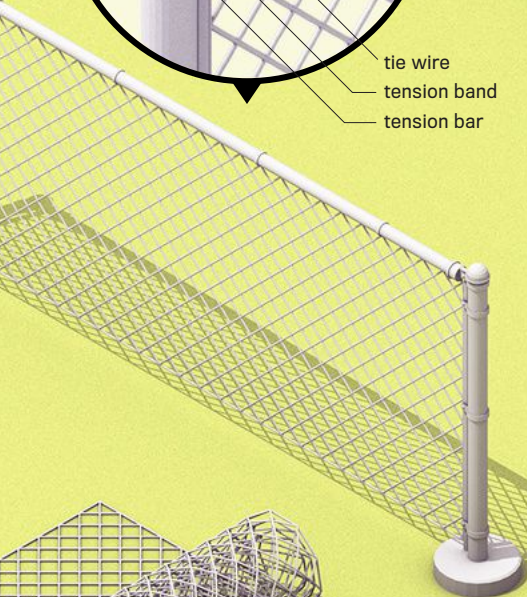
ILLUSTRATIONS
BY TIMOTHY J.
REYNOLDS

SKILLS

YARDWORK



tie wire
tension band
tension bar



THE JUNK: CHAIN-LINK FENCE

A rusty old fence on a property speaks volumes about its owners. Or, rather, it shouts really unfortunate things about them to the entire neighborhood, such as "We're weird, and our devil dog might eat your children." But you only have a cat!

GET RID OF IT

1. First, snip the tie wires that hold the fabric of the chain link to the top rail and posts, then loosen the bolts on the tension bands, the connectors that hold the tension bar to the end posts. Do the same to the brace bands that hold the top rail to the other posts. Drop the chain-link fabric and roll it up. Slide the top rail out and set it aside.

2. The end posts are usually set in concrete. Dig an oval-shaped hole around the concrete footing and pry it out using a pinch-point bar. The post itself also works as a lever if you pull the top toward you, then rotate the footing up and out of the hole. Alternatively, a large hydraulic fence-post jack can pull a post out of the ground, footing and all. If you rent one of these, you'll find it's worth every penny.

3. If the concrete footing rests far enough underground, you can also use a reciprocating saw with a metal-cutting blade to cut the post flush with the ground, and pound the stub with a sledgehammer until it's sufficiently deep to be safe. Sometimes when doing this, you'll get lucky and the footing will break up. Then you can change tack and lift it out in chunks.



THE JUNK: AN OVERGROWN SHRUB

It was probably beautiful when it was trimmed in the shape of an Italian cypress. Now it looks like a 500-pound hamster.

GET RID OF IT

1. Don't start at the trunk. Snip off large branches with bypass loppers until you can get close enough to the trunk to saw it off with a chainsaw outfitted with a semi-chisel chain, which is ideal for hard and dirty cutting conditions. Make sure to leave enough of the trunk to form a handgrip or even a lever to help you get the root ball out of the ground.

2. If you intend to plant in or near the same hole, the stump and roots have to come out. The more tree-like the shrub, the more difficult this can be. Expose as much of the stump below the ground as possible by digging around it with a shovel, pickaxe, and chisel-point pry bar. Cut the roots using the chainsaw if you can do so safely and without hitting a rock or burying the saw's nose in the dirt. If you can't, use a reciprocating saw and a bimetal blade designed for cutting wood with nails embedded in it. After the roots have been severed and all that's left is an oddly shaped hunk of wood, pry it out with your pinch-point bar. You can put your foot on this in a gesture of victory, if you like.





↑
THE JUNK: PAVEMENT

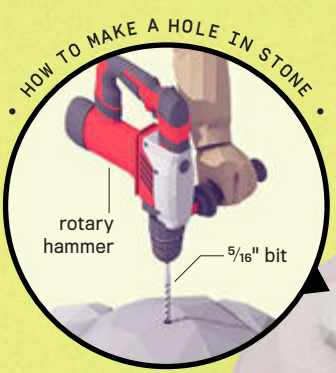
A patio whose janky, cracked foundation trips you up while you're holding a tray of freshly grilled steaks is no patio at all.

GET RID OF IT
1. Busting up a concrete slab with a pavement breaker is hard, loud, dirty, and exhausting, so start with the right machine. Pavement breakers range from tools you can use with one hand to industrial monsters powered by four-cylinder engines. You want the heaviest electric model you can get. These machines weigh sixty to seventy pounds and are available at tool-rental stores.

2. Begin at one edge of the pavement and run the breaker's bit straight down to break off pieces that are about four inches wide. In most cases the work goes reasonably quickly, but all bets are off if you run into reinforcing metal like rebar or welded-wire mesh.

3. If you do hit metal, you'll need to rent a power cutter, a gas-engine circular saw equipped with a diamond-impregnated blade that cuts concrete and the reinforcing metal in it.

4. After the pavement is broken (or broken and cut), shovel or lift it into a contractor's wheelbarrow for transport to a dumpster with a swing-out door. This will allow you to wheel the debris right in and then drag your exhausted body back out. Good job. Go get a beer.



↑
THE JUNK: ROCKS

It's like they move themselves to the worst possible place. You dig for a foundation. Rock. Plant a tree. Rock. Lay out a garden? Clear, loamy topsoil. Just kidding: A rock!

GET RID OF IT
To deal with a big one, blast it to smithereens with an EzeBreak Micro-blaster, a small-scale blasting kit that you don't need a license to own or use. To start, make a few holes in the rock with a rotary hammer. Thoroughly clean the holes to

remove dust and chips, then insert the Micro-blaster's small smokeless-powder charges into the holes. These look somewhat like .410 shotgun shells. Insert firing pins on top of the charges, then activate the pins with compressed air. It's safe and extremely effective. Rocks are fun.

If We May:
LEAVE THE TREE-HOUSE LADDER Not the whole thing. Certainly not anything made of plastic. But a weathered board or two nailed sideways to a tree. Sand the edges. Hang a birdhouse. You can figure out some way to make it look nice. A home should have a little history, and if the children of the former owners come to visit, you'll make their day.

SKILLS

APPLIANCES

You have a pocket computer, so your microwave shouldn't look like it came with a slap bracelet. Try the Breville Quick Touch. It has a sensor that can automatically adjust cooking times.

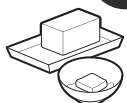


THE SMART MAN'S GUIDE TO MICROWAVING

A refresher course for the hottest culinary gadget of the 1980s. **BY DAN PASHMAN**

A MICROWAVE IS A TOOL that few of us use to its full potential. Cue the physics professor: Inside a microwave, a vacuum tube called a magnetron blasts electromagnetic waves at whatever's placed in front of it, the same way a light, an X-ray, or a radio does, but at a different frequency (2,450 megahertz). Waves at this frequency, called (duh) microwaves, make water molecules in food vibrate, heating them up. To use this information to make tasty food, see below.

8 seconds



PERFECTLY SPREADABLE BUTTER

High heat causes milk solids to separate. Even putting the butter back in the fridge won't fix that. Cut off the piece you plan to use, set the microwave to medium power, and watch it to make sure you don't overheat.

25 seconds



LAST NIGHT'S STEAK

If you go too long or too hot, you could continue to cook the steak, turning your medium rare into medium well. Instead, let the steak come up to room temperature before heating it on medium-high power.

30 seconds



SMOOTHER HONEY

Honey crystallizes when some of its sugars come out of solution, but that doesn't mean it's gone bad. Honey never goes bad. Heating it will allow the sugars to redissolve, returning the honey to liquid form.

2 minutes



LEFTOVER RICE

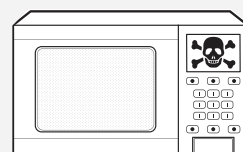
Old rice undergoes a process called retrogradation, in which starch molecules squeeze out water. To temporarily reverse it, sprinkle water over the rice, stir, top with a paper towel, and microwave until it's insanely hot.

THE SORT-OF-SCIENTIFIC SCIENCE EXPERIMENT

Can a microwave interfere with your Wi-Fi?

I've read online that microwaves can derail a Netflix marathon by interfering with Wi-Fi. But there are a lot of lies online. To learn the truth, I set my iPhone 6 Plus to wirelessly sync music files, and my MacBook Air to stream live TV. Then, with both devices gulping data, I set them on the counter inches below a 2014 GE microwave, reheating coffee for one minute at 100 percent power. After just fifteen seconds the data flow to my phone and laptop halted.

Marcus Weber, a researcher at Stanford University, says that this is the microwave signal "saturating" the receivers in my iPhone and MacBook, both of which have filters designed to absorb 2,450-megahertz waves. This would be a problem, except that both devices returned to full speed after the minute ended. If necessary, I could set my router to transmit at 5 gigahertz instead of 2.4 gigahertz, but even I, a tech editor, can survive a minute without Wi-Fi. —ALEXANDER GEORGE



IS MY MICROWAVE GOING TO KILL ME?

No. Unless you put plastic in it, in which case maybe. The radiation in microwaves does not contain enough energy to remove electrons from cells the way X-rays can. If your microwave's shield is very leaky, it could potentially heat you the same way it heats food, but this is unlikely. However, certain chemicals, such as phthalates and BPA, can leach out of hot plastics and interfere with hormonal signaling, which is not ideal. To be completely safe, use only plastics labeled microwave safe, or put your food on a plate, you animal.

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SKILLS

THINGS COME APART

A PHOTOGRAPH BY
TODD McLELLAN

THE OTHER BITS

The **Bosch DDS182** drill driver is cordless, brushless, and wireless, but still comes with a lot of stuff.

IN GENERAL, THE MORE BITS, ACCESSORIES, AND ATTACHMENTS you buy for a drill, the more likely that drill is to be useful. So it might seem strange that today's power drill manufacturers seem intent on removing stuff. Take this Bosch DDS182 drill driver. The drill itself is cordless, its motor is brushless, and the charging system is wireless.

The Bosch still has plenty of parts, of course (see photo). What the manufacturer has removed are the pieces that aren't useful: The ones that stand in the way of the drill in its purest, most essential form. Without a cord, you can take it anywhere you want. Without brushes, the motor lasts longer. Without wires, you can charge it every time you set it down.

More important, the key feature remains: It's great at making holes.

— KEVIN DUPZYK



1 KEYLESS CHUCK:

The Bosch's chuck uses a system of gears to loosen or tighten teeth that hold the bit in place. Older models required a separate tool to open and close the teeth. It was always promptly misplaced.

2 CLUTCH AND GEARBOX:

The gearbox delivers power from the motor to the drill bit. The clutch system decouples the motor from the bit when torque is too high, preventing stripped and overdriven screws. This is a ball detent clutch: A spring presses ball bearings into notches to engage the drivetrain. When the torque overpowers the spring, the balls pop out of the notches, and the clutch slips.

3 CLUTCH SETTING SELECTOR:

Turning this collar to a higher number adds tension to the spring in the clutch assembly.

4 BRUSHLESS DC MOTOR:

Whereas traditional motors rub conductive brushes against a commutator to generate magnetism and, subsequently, rotation, brushless motors use an electronically controlled system that is contact-free. Without friction, a brushless system is more durable.

5 TRIGGER/SWITCH ASSEMBLY:

The trigger is the button you push with your finger. The switch is the electronic device that translates this pressure into a signal the motor understands.

6 DRILL CIRCUIT BOARD:

The tool's control center. While some manufacturers control the tool from the battery, keeping these functions on board allows the tool itself to fine-tune power demands based on load.

7 INDUCTIVE CHARGING COILS:

Copper in a plastic case. Each coil is, essentially, half of a power transformer—the charger contains one side, the battery the other. When the battery is placed near the charger, the charger's coil induces a current in the battery's coil. This current is then stored as energy.

8 BATTERY CASING:

Made of a heat-conducting material that is molded into fins to increase surface area, it allows heat to dissipate quickly.

9 BATTERY CIRCUIT BOARD:

First it communicates with the charging station to load energy, then it communicates with the drill to dole it out as needed.





What if I accidentally set my drill bits or pocket change on the wireless charger? Will it charge them?

No. When you set the drill on the base, the charger sends an electronic message to the battery to ensure that it's actually the battery, like an air traffic control tower sends to a plane. If the battery doesn't confirm, the base sends no energy. Which is too bad, because this thing could have been one hell of a mousetrap.



THE KIDS IN THE GARAGE

How to strip, repair, repaint, and rewire an old car—with help from an after-school auto club. Part four of a six-month series.

WHEN SETH REHRAUER ISN'T WORKING ON CARS IN THE FREEDOM HIGH SCHOOL garage in Freedom, Wisconsin, he's likely to be maintaining some very different vehicles at home. "I've been racing snowmobiles for five years," he says. "I have a mechanic who works on my snowmobiles, and he's been teaching me stuff." Rehrauer, a 17-year-old junior, is currently taking only one automotive class at school, but he also pops by the garage during his study hour and after school to help out. While some kids have been priming and painting the body panels on the 1974 Oldsmobile Delta 88 and the 1981 Chevrolet Camaro Z28 we've been following, others have been working on the interior or mechanicals. For Rehrauer, plastic repair is the hardest skill to master. "It's complicated because you have to lay the repair perfectly," he says. "If you don't, you'll get holes when you sand it. Then you have to redo it." Even with all Rehrauer's extra hours in the garage, he doesn't have time for that.

Freedom High junior Seth Rehrauer applies 3M plastic repair to the Camaro's cracked dash.

THE SUPERGLUE OF CAR REPAIR: SPRAY PLASTIC



Kick panels are called that for a reason. Those quadrants of plastic next to the door and just below the glovebox get more abuse than a well digger's wristwatch. One good boot and you've got a crack. Instead of spending a hundred bucks on a new panel, just fix it yourself. Remove the panel, turn it over, prep the surface, and push the plastic together while applying 3M Semi-Rigid Plastic Repair. Once it's dry, reattach the panel and spend the money you saved on something else. A snowmobile, maybe.

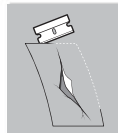
HOW TO

REPAIR A CRACKED DASH

Tips from the Freedom High School Automotive Program.

STEP ONE

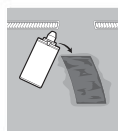
Cut out the damage.



Use a razor blade to cut a border around the damaged plastic or vinyl, then peel or rip it off, along with any other areas on the dash that feel brittle. To check for brittleness, press your thumb into the dash. If the vinyl feels hard or cracks, it's no good.

STEP TWO

Fill the crack.



Next, spray some 3M Polyolefin Adhesion Promoter on the exposed foam rubber. Then apply a thin layer of 3M EZ Sand Flexible Parts Repair, an epoxy that dries like

hard plastic. Cover the entire hole and a bit of the surrounding plastic with a thin layer. Once the EZ Sand is dry (the label should specify the required time), sand it even with the rest of the dash using 320- or 400-grit sandpaper. The patch will be thin. Be careful not to create holes.

STEP THREE

Apply texture and color.



If you're repairing a large part of the dash in a basic color like black, you could use a textured paint or even bed liner to cover the damaged area. Both mimic the surface feel of vinyl. For a smaller or more colorful fix, spray a layer of black SEM Texture Coating paint over the sanded

area to duplicate the original texture. When dry, apply a coat of SEM Color Coat in the same color as your dash.



NEXT MONTH

Brake Repair

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TOOL TEST

THE PONY OF SHOP VACS

When it comes to tools for cleaning the garage, sometimes smaller is better. **BY ROY BERENDSOHN**

A WELL-USED WORK SPACE WILL ALWAYS CONTAIN A mess. Like that old adage about cracking eggs to make an omelet, you can't build a chair without scattering sawdust all over the floor. This is the benefit of a small-size shop vac: It can easily suck up drywall dust or toilet-tank water while you do your project, instead of you having to haul the big machine out of the basement afterward. To find out which of these six spunky vacuums could handle a workshop's worth of wreckage, we ran time trials as they pulled up two pounds of sawdust, two pounds of screened topsoil, and one gallon of water, then averaged the results.

RIDGID WD3050 \$50 ★★★★★ ▶

Time trial: 6.4 sec
Tank size: 3 gal
Cord length: 10 ft
Noise: 88 dB (A-weighted)
Likes: Our winner is fast and powerful. Its large, clog-resistant hose is supple and easy to work with, even in cold weather. The same goes for its

power cord. And nothing came close in our test for sucking up a gallon of water: It pulled it off in 2.2 seconds. Most vacs take twice as long.
Dislikes: It is a bit top-heavy. This abates as it gets weighted down with debris.



BEST OVERALL

6 lb



4 lb

★★★★★

SHOP-VAC 9302511 \$30

Time trial: 9.6 sec
Tank size: 2.5 gal
Cord length: 6 ft
Noise: 86 dB (A-weighted)
Likes: The Shop-Vac is reasonably fast and powerful, and its ability to pull in a variety of rubbish quickly makes it well-suited for mid-duty cleaning.
Dislikes: The hose is a bit stubby, and though the large air filter catches a lot of particulates, it does take up tank space.



5 lb

★★★★★

VACMASTER VHB305M \$40

Time trial: 9.8 sec
Tank size: 3.2 gal
Cord length: 15 ft
Noise: 87 dB (A-weighted)
Likes: This was the only vac to come with a four-wheel caddy and wall-hanging hardware, which make this versatile appliance good for both wheeling around the construction site and wall-mounting in the garage to clean dirt off the car's floor mats.
Dislikes: None.



6 lb

★★★★★

DEWALT DCV581H \$118

Time trial: 12.6 sec
Tank size: 2 gal
Cord length: 8 ft
Noise: 88 dB (A-weighted)
Likes: The most expensive vacuum was also the most well-rounded. It runs on an 18- or a 20-volt cordless-tool battery or a wall outlet, and you don't need to change its air filter when switching from dry to wet.
Dislikes: As you empty the tank, its lip catches the dirt, which is a nuisance.



4 lb

★★★★★

ARMOR ALL AA255 \$31

Time trial: 11.6 sec
Tank size: 2.5 gal
Cord length: 10 ft
Noise: 83 dB (A-weighted)
Likes: Our quietest vacuum is perfect to take inside the car (though you should still wear hearing protection). It has more than enough power for light-duty cleaning, and a handy Velcro band for the power cord.
Dislikes: Boy, that power cord is stiff, especially in cold weather.



3 lb

★★★★★

CRAFTSMAN 125.12001 \$30

Time trial: 11 sec
Tank size: 2.5 gal
Cord length: 10 ft
Noise: 94 dB (A-weighted)
Likes: It comes with hanging hardware and has plenty of power for general cleaning. It also did particularly well in our test for pulling in water, averaging 3.75 seconds. That's as fast as our 4½-star machines.
Dislikes: It's fairly powerful, but IT WAS AWFULLY LOUD.

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ASK ROY

Popular Mechanics' senior home editor solves your most pressing problems. BY ROY BERENDSOHN

I have a ceiling light that works sporadically. It's not the bulb. I've taken the light down and looked it over, but couldn't see anything wrong. How hard can it be to diagnose? We're talking one switch and one fixture.

Frank A., Philadelphia

I'm glad you said one light and one switch. Circuits that are more complicated than that usually require an electrician. I think you can handle this, though.

To diagnose this at home, you need a multimeter, a battery-powered instrument that tests voltage, current, resistance, and continuity. Inexpensive versions cost about \$10.

In this case you'll use the meter to check for continuity, the integrity of an electrical path. First, cut off the power to the light at the service panel, then loosen the screws holding the fixture to the ceiling box, lower the fixture, and undo the connectors that attach the fixture's two wires to the house's wiring.

Install a standard incandescent bulb in the fixture. Now set the meter's dial to continuity, and match the meter's leads to the two wires coming out of the fixture. It doesn't matter which lead goes to which wire. If there's a continuous electrical path, the meter will produce a tone. If it doesn't, remove the bulb from its socket and use needle-nose pliers to pull up the brass tab at the bottom. Reinstall the bulb and test again.

If the fixture tests okay, leave the power off and run the same test on the switch: Remove the switch from its box and connect the meter's leads to the switch's brass terminal screws. Again, it doesn't matter which lead goes with which screw. When the switch is flipped to "on," the meter should produce a tone. If it produces an erratic tone or no tone, the switch is bad. If both the switch and the fixture test okay, you have a bigger problem. Call an electrician.

Does anybody make a rack to mount a shovel on a wheelbarrow? Every time I move a wheelbarrow with a shovel in it, the handle gets in my way.

Nancy E., Wichita, Kansas

A rack strikes me as impractical. Do what countless construction workers do: Tuck the shovel's handle under your arm and rest the head in the wheelbarrow as you move it.

Our house has ugly, beat-up baseboard trim that's fastened every three inches with a pair of large finish nails. I've damaged the drywall trying to get the stuff off. Any ideas?

Brent N., Cathedral City, California

One option is to trim over it. Some Lowe's home-improvement stores have started selling moldings that

are made from a continuous piece of MDF (a material similar to Masonite) called RapidFit. They have a traditional profile on the front, but the back is an L-shaped cavity. You place the new moldings over the old and fasten them on with 4d finish nails. Putty the nail holes, paint, and you're in business.

If you'd rather just get rid of the old moldings, slide the straight end of a fishtail pry bar between the trim and the bottom wall plate and pry forward. That should get the moldings started. After that, use a crowbar. It'll be loud and nasty, but it shouldn't harm your walls.

We've got threaded steel pipe in the basement that leaks. My husband has taken it apart, wrapped it with tape, and put it back together. Twice. It still leaks. Can you help?

Rita L., Ann Arbor, Michigan

When a threaded joint leaks, the natural response is to tighten it. Sometimes that stops the drip, but if you overtighten the joint, you could ruin the threaded parts and make the problem worse.

Most likely only one of the pipe's fittings has stripped threads. To fix it, replace the pipe and bad fitting. There's no need to replace the fitting at the other end. First, apply a generous amount of professional-grade pipe sealant such as RectorSeal No. 5 to the male threads of the new pieces.

Once the new pieces are as snug as you can get them with your bare hands, you need only a full turn to a turn and a half with tools. Hold the fitting or the pipe with one wrench, and with another turn the part you are tightening. Plumbers call this back holding. With RectorSeal you can send water through immediately.



Are You
Sure You
Know How to
Use That?

PIPE WRENCH
EDITION

A pipe wrench is a hardy tool, not given to easy breakage like a thin saw or a drill bit. Heck, it's a weapon in the game of Clue. But if you forget to leave a small space between the back of a wrench's hook jaw and the pipe you're gripping, you could strip the teeth, bend the jaw, or damage the tightening nut. A wrench's jaws aren't parallel, and their natural wedging action tightens around the pipe as you turn. "Leaving a space permits the jaws to tighten with just the right amount of give," says Chuck Stephens, director of service and training for Ridgid tools, who has been using pipe wrenches professionally for thirty-seven years. If you forget the space, you could turn your best wrench into a decorative piece of cast iron, which is only a good thing if you're a blacksmith.

UP AHEAD

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Volvo's
virtual test
drive

By
**Ezra
Dyer**

CARS

503 horsepower,
zero to sixty in
3.7 seconds.



A MERCEDES SPORTS CAR COMES DOWN TO EARTH

The 2016 Mercedes-AMG GT S is more practical than its predecessors, but it's still just as fast.

NINE YEARS AGO the flagship Mercedes was the SLR McLaren 722 Edition. That car did zero to sixty in 3.6 seconds, cost nearly a half-million dollars, and looked like the SL500's coked-up uncle. It was replaced by the SLS AMG, a car that seemed sensible by comparison—it was just as quick off the line as the SLR but cost a mere \$200,000. Now the SLS is gone, replaced by the Mercedes-AMG GT S, which starts at about \$130,000 and does zero to sixty in 3.7 seconds (close enough). As far as Mercedes performance variants go, this is the democratization of power.

There is, of course, a catch. In order to keep the price down, AMG had to dial back the outrageousness and build a more conventional sports car. The SLR had a carbon-fiber tub and scissor doors. The SLS had gullwing doors attached with pyrotechnic bolts, in case you flipped it over and couldn't get out. The GT S makes do with regular front-hinged doors, which, I admit, work just fine. But, unfortunately, you no longer

2016 MERCEDES-
AMG GT S

PRICE: \$130,825



FLATTEN THE GAS AND THE TIRES ISSUE A TORTURED WAIL BUT REFUSE TO GO UP IN SMOKE.

look like an astronaut exiting your lunar capsule every time you step out at Dairy Queen.

My GT S drive begins in Miami Beach, which is a tough place to exercise a twin-turbo V-8. So I head over to the Grand Theft Auto badlands of downtown Miami, where one can still find empty streets and room to run on any given weekday morning. Over there, in the shad-

ows of the overpasses, you have to do more than squeal the tires to draw a second look from the cops.

And I certainly did get a little bit obnoxious. The GT S has an exhaust-bypass button that diverts as much as 95 percent of the exhaust flow around the mufflers, sending V-8 bass echoing off the bridge abutments and shuttered storefronts. Conventional wisdom says that turbochargers act as mufflers, but the GT S is a rolling refutation of that idea. It's not quite as loud as a Jaguar F-Type V-8 S—not much is, outside of large artillery—but you won't weep for the departed 6.2-liter V-8 that powered the SLS.

You also won't miss the SLS transmission, because it's still here. The GT S gets the Getrag seven-speed dual-clutch transaxle last seen in the \$275,000 SLS AMG Black Series. Situated over the rear wheels, the transmission contributes to a 53 percent rear-weight bias that helps the GT S deploy its 503 horsepower. Flatten the gas and the tires issue a tortured wail but refuse to go up in smoke. This is a sports car, not a German Hellcat.

In fact, the AMG GT S feels a lot like an SLS AMG—similar acceleration, similar sound, similar view over that long hood—but at a \$70,000 discount. (We can now guess how much those gullwing doors cost: \$35,000 each.) So I understand the logic of taking AMG's halo machine down to less rarified air. But I'll still miss looking like an astronaut.



This Month in Cars . . . in Movies

In *Beyond the Reach* (in theaters April 17), a very rich hunter accidentally shoots a reclusive prospector in a remote desert, then tries to cover it up by leaving his young guide to die in the heat. There are four main characters: the man (played with a sinister charm by Michael Douglas), the guide, the desert, and a car. A big car. A six-wheel-drive Mercedes G63 AMG that looks like a safari war limo. The limited-edition vehicle was originally designed for the Australian army, with a few extras made for oil barons and anyone else who needed people to know they could find hundred dollar bills in their couch cushions. The standard AMG has 536 horsepower, 37-inch tires, and adjustable tire pressure. The one in the movie also has a motorized gun compartment, an espresso machine, a PA system, and articulating automatic floodlights, but, sadly, no speaking parts.

—PETER MARTIN



The Downside of LED Headlights

People think you're a high-beaming jerk.

The guy across the intersection flicks his high beams at me, just like the oncoming Buick did a half-mile ago, just like a pickup will do a few minutes later. They're telling me that I've spaced out and left my high beams on, that I'm a negligent dummy with his brights ablaze. Except my high beams aren't on. I'm driving a 2015 Kia K900 with LED headlights, and everyone thinks they're too bright.

What's going on? The issue, I think, is that each LED lighting element is so distinct. The K900 has four low-beam LEDs on each side, so oncoming drivers perceive four individual lights rather than one big bulb. The general public, accustomed to composite headlights, is disarmed by the white, naked splendor of LEDs. So they high-beam you.

As for the people who think I'm blinding them, I conduct an impromptu public education seminar. I flick the Kia's headlight stalk and give them a taste of actual LED high beams, which light up the intersection like Rikers Island searchlights during a prison break. They won't flash me again.



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CARS



Drives

Three oldies but goodies and one (almost) all-new sedan.

2015 Aston Martin Vanquish Volante

PRICE: \$305,820

Aston reintroduced the Vanquish a couple of years ago, but 2015 brings a major upgrade: the first transaxle version of ZF's marvelous eight-speed transmission. Adding two gears makes the Vanquish feel like it has an extra fifty horsepower, with the zero-to-sixty time dropping to under four seconds—solid supercar territory—and the coupe reaching a top speed of 201 miles per hour. The droptop Volante, though, seems like the Vanquish sweet spot, allowing onlookers to gawk at that knockout interior and giving the driver an even bigger earful of the 5.9-liter V-12's metallic cry. A new transmission isn't the sexiest revision you can make, but it's a smart way for Aston to improve performance without a major overhaul. Besides, you start this

car with a \$2,000 key made out of crystal. It's sexy enough.

2015 Toyota Camry XSE

PRICE: \$26,975

Toyota claims that the 2015 Camry is so extensively redesigned that the only carryover part is the roof. That's not entirely accurate, since the powertrains are familiar from the prior Camry as well as a slew of other Toyotas. The new interior's nicer, though, with handsome French stitching and extra sound deadening under the carpet. While there aren't many surprises with a Camry, the new XSE model makes a play for younger drivers who might otherwise consider the Honda Accord Sport. With its blacked-out trim and firmed-up suspension, the Camry XSE is like the hardest dude in a white-collar prison, the CPA who went rogue. But, hey, the optional

268-horsepower V-6 still hurls the Camry off the line with gusto, its raspy snarl at odds with the sensible vibe. For Camry buyers, that might be just the right amount of excess.

2015 Infiniti Q60S

Coupe Limited

PRICE: \$50,555

I'm unlocking the Q60S at the airport valet lot when a woman shouts, "Want to trade cars?" She's standing beside a Hyundai Elantra, so I say, "Sure!" in a way that means "That's unthinkable!" But I'm impressed. Now in its eighth year, the Infiniti coupe still turns heads. If you haven't kept track, this car's had more names than Snoop Lion—first the G37 Coupe, then the G Coupe. Now it's the Q60. Whatever you call it, the Limited version looks killer with its black wheels and grille. And the high-revving 3.7-liter V-6 has an exhaust note so distinctive, you can recognize it over the phone. (No joke: I've done it.) Infiniti is embracing a digital future, but the Q60 is still an analog machine, with an available manual transmission, a limited-slip differential, and a tail-happy rear-wheel-drive chassis. Let's not take it for granted.

2015 Mazda MX-5 Miata

PRICE: \$24,765

Why pay attention to the 2015 Miata when a redesigned model is on the way for 2016? Because it's still a damned good car and unlike anything else you can buy. Having outlasted the Honda S2000 and Pontiac Solstice/Saturn Sky, the Miata is your sole option for affordable top-down corner carving. Although this design is now nearly ten years old, it's got the goods: rear-wheel drive, a six-speed manual, and a sweet-revving four-cylinder. And if you prefer your throwback roadster with a dash of luxury, 2015 will be the last year for the retractable hardtop. This Miata's been around awhile, but honest fun never gets old.

Miata Math



2014 Jaguar F-Type

+



Cheshire Cat

=



2016 Mazda MX-5 Miata
AVAILABLE:
LATE SUMMER



The Armchair Test Drive

Volvo's new virtual-reality smartphone app lets you take a spin from your living room.

Volvo's Other App

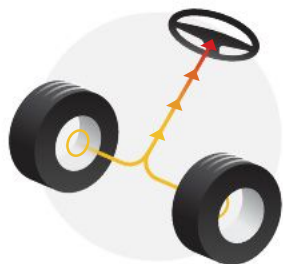
A couple of months back, an executive from a luxury carmaker was talking up the range of its new key fobs, particularly the remote-start function. I said, "Oh yeah, well, the Volvo On Call app lets you start your car from your iPhone." He replied, "Yeah, we thought about offering remote start through our app. The problem is, how do you keep someone from starting the car when it's in a garage?" The implication is that, through malice or mistake, someone could start a car indoors and inadvertently gas the place with carbon monoxide. So I asked Volvo if On Call can tell the car's in a garage. Answer: not right now. On the other hand, nefarious remote starting hasn't been an issue. Still, the app suggests leaving your hood popped to prevent an accidental startup. Want to be really sure your car doesn't start? Disconnect the battery.

I'VE ALREADY DRIVEN the 2016 Volvo XC90. Not in person, mind you. I've driven it on a virtual-reality headset. Which is just a cleverly folded piece of cardboard with my iPhone inside. Welcome to the age of the Google Cardboard test drive.

Volvo Reality is one of the few iPhone-compatible apps for Cardboard, a DIY viewer made using free instructions online. The free app splits your screen to give each eye a slightly different view, while the phone's accelerometer tracks head movement to adjust the scene. Put it inside Cardboard and voilà: 3D. Next thing you know, you're flying into the wilderness to drive a Volvo.

Episode one opens with a black XC90 parked among trees. Soon you're inside, driving along a bucolic mountain road. The view is from the driver's seat, but there are no hands on the wheel. Help, I'm trapped in a ghost car! You can look around the interior as you drive, and why not? This thing practically drives itself.

Eventually you end up at a lake, and a graphic reads, "Friday, 8:27: My home for the night." At first I assume I'm sleeping in the car, but if you swivel your phone around you see a tent down by the water. Although I still think I'd prefer the car. That interior looks pretty nice.



In Praise of Hydraulic Steering Because it's still the best you can get.

Electric power steering is so prevalent that I just assume every new car has it. So when I'm hustling the 2015 Subaru WRX STI down a country road, its wheel alive with feedback, I think, finally! Someone's figured out how to build a really excellent electrically assisted steering system. Then I reach a stop sign, turn the wheel, and watch the tachometer dip as the engine lugs—the telltale sign of a hydraulic pump imposing drag. Indeed, the STI is one of the few hydraulic holdouts, and as a result it might have the best steering of any new car, a system perfected over years of development. Of course, the STI also gets a miserable nineteen miles per gallon combined, a figure that would doubtless be higher if Subaru went electric. But in this case, Subaru has its priorities in order. And everybody else has a benchmark: Want to build the best steering system? Make it feel like a 2015 STI.

A BEAUTIFUL

THE DEERSKIN RANCHER



IT STARTED when James Churchill traded a cache of tinware—the family has lost track of how or why he'd been trading in pots and pans—with the local Chehalis Indians for their brain-tanned deer hides. It was 1895 in Centralia, Washington. Churchill had come down from Ontario, and the timber industry was booming. The men in the timber mills needed to protect their hands, and so Churchill used his stash

of tough yet soft and pliable elk and deer leather to make work gloves. From the timber business a glovemaking business was born.

Churchill died in 1932, and his 29-year-old son Niles took on the family trade, eventually establishing a new factory just down the road in 1946. Then in 1968 Niles's son Niles James got out of the Marine Corps and began overseeing day-to-day operations. Andy and

Mike Churchill, Niles James's two sons, have been running things since 1988, though their dad will still show up to cut and sew gloves now and then. Through the decline of the timber industry, their entry into the motorcycle-glove market, even through a drought in the Midwest a few summers ago that reduced work-glove orders from farmers to near nil, a Churchill at the helm has remained constant.

FULL THING



COMPANY:
James Churchill
Glove
Company
LOCATION:
Centralia, Washington
OWNERS:
Mike and Andy
Churchill

The rancher gloves today are cut from one of the first patterns the company used in the 1890s. The style of the thumb and fingers, with its snug fit favored by cowboys, matches a pair of motoring gauntlets that were sewn by Mike's great-grandmother in 1915. They're made to last. Individual customers go twenty years, putting the leather work gloves through hell before calling up looking

for new ones. Deer and elk hides come in from tanneries in Tennessee and Wisconsin. Andy presses them in an ancient machine that no one else is insured to operate—the patent date forged on its side says 1890—stretching out the skins for greater yield and an even thickness. Workers cut the leather with steel dies and sew on electric machines now. Thankfully, not everything is as it was.

Mike and Andy both have college-age kids, and while it's not a guarantee or requirement, they expect that one of them will look after the company when the time comes. Twenty years from now, when a customer who just bought a pair today trades in for a new set, Mike and Andy hope the gloves will still be coming out of Centralia from a member of the family.

— MATT GOULET

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Start With the Right Gear

► Your phone may be convenient, but it is not a camera. Even a point-and-shoot, while definitely an upgrade, won't get you the control or the advanced sensor you need to take great pictures. For a long time the DSLR, with its nearly instant autofocus and interchangeable lenses, has been the only choice for serious digital photography. But in the past ten years a new category has gained popularity: Mirrorless cameras like the Sony a6000 (\$550), above, remove the mirror that bounces an image from the lens to the eyepiece in a DSLR, instead relying on a digital

viewfinder. Without the complication of a mirror, these cameras are lighter, more compact, and much less expensive than DSLRs, while producing nearly the same quality of image. You're the only one who has to know.



Do Something With Your Pictures



► Like store them in a smart way that allows you to easily search and access them when you need to. First, forget the cloud. You'll have more immediate control over an external drive dedicated to your photos. The four-terabyte **WESTERN DIGITAL MY BOOK (\$140)** has plenty of room, no matter how itchy your shutter finger. Plus, it lets you store everything in one place, not spread out over your computer, Facebook, and photo sites. All you have to do is drag your photos to it after you import them.

vacation in 2008. Group the images into categories such as birthdays, vacations, and holidays. Each event gets its own folder, and each of those folders gets two folders: one for the originals and one for any corrected files.

► Pick a naming system, and stick to it. Don't use dates. It's much easier to remember that you went to Hawaii than it is to remember that you took a

SOMETHING TO CONSIDER

Digital Deteriorates

If you still have any photos saved on CDs, move them to a hard drive, or at least put them on Dropbox, as soon as you can. As CDs age, their protective lacquer coating breaks down. This allows air to reach the aluminum and rust the disc, changing the chemical composition and eventually making it impossible to read the data.



INSTANT IMPROVEMENT >> THE LIGHT METER

You may feel silly using it, but if you really want to get serious about taking photos, you need an incident light meter. It reads the light falling onto a subject directly from the source, as opposed to the light reflecting off the object and back to the camera (along with all the other light entering your camera lens). That lets you adjust your exposure to your focal point, not to the entire scene.

— IAN ALLEN, PHOTOGRAPHER





Fix Them

Think of this less as editing and more as processing. You're turning a negative into a developed photograph. Although the software that comes with some cameras can be quite good, don't worry about installing it. Every expert we consulted suggested Adobe Photoshop Lightroom, for \$10 a month, or a free program called Gimp that offers almost all of the same features. A look at the key functions you'll find in both:



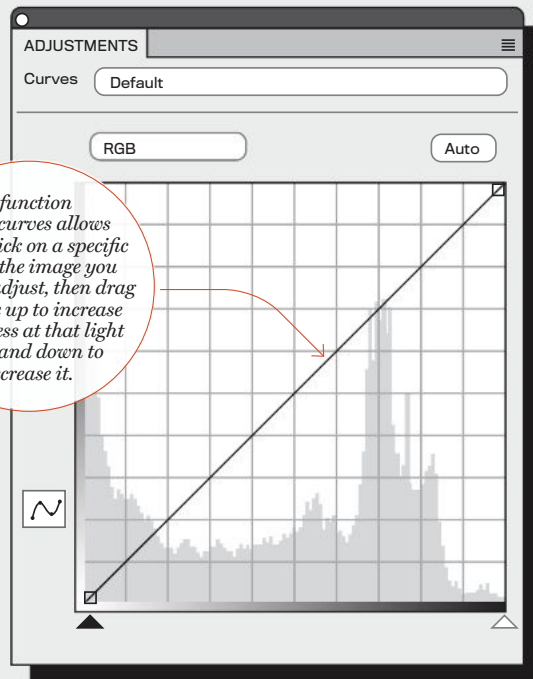
CROP: Remove distractions, but try to keep limbs and background objects complete. Use the classic rule of thirds to line things up by imagining a tic-tac-toe board over the photo (like we did in the image above). Viewers automatically focus on the intersections, so try putting a subject's eyes along the top line. And keep it a little off-center. Too much balance is boring.

EXPOSURE: Raising the amount of light brightens the image, bringing out hidden details in the darkness. Lowering it darkens the image, retrieving details that were lost in the light.

FILTERS: Reserved for amateurs. You're better than that.

EVERYTHING ELSE: Based on the histogram. See right.

A function called curves allows you to click on a specific part of the image you want to adjust, then drag this line up to increase brightness at that light level, and down to decrease it.



HOW TO USE A HISTOGRAM

► **THE VERTICAL AXIS** shows the number of pixels at each light level. (A nighttime photo of a candle's flame will have high spikes to the left, since most of the image is in darkness, and a sunny beach shot will be shifted all the way to the right.) It depends on what you're shooting, but generally speaking, you want more of

the pixels to be in the middle of the graph than on the very edges.

► **THE HORIZONTAL AXIS** displays the full range of brightness in an image, progressing from pure black, on the left-hand side, to pure white, on the right. There is a slider on the bottom of the chart. Move the left arrow to make the darks darker, and the right to make the lights lighter.

detail. Shadows may be hiding texture, or something might be washed out in the sun. It's a sign that you should have adjusted your exposure up or down to compensate when you took the picture.

► **COLORS** Photoshop and Gimp let you pick specific colors and adjust their levels. Generally, you won't need to do this. There's an "auto" button that has earned its reputation. But if a photo still feels too warm (red) or cool (blue), you can adjust it with the colors function. Select the color from the drop-down, then move the line in the appropriate direction to change saturation or brightness.

→ INSTANT IMPROVEMENT >> GET ONE GOOD LENS

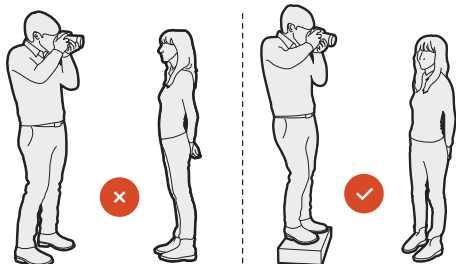
Crappy lenses distort color and cause fading at the edges of the shot. Start with a prime lens—this Sony E35mm F1.8 OSS E-mount fits the a6000 on the previous page—which will get you sharper photos and, since it can't zoom, will make you think about composition. You zoom with your feet. — **ESTEBAN ALADRO, PHOTOGRAPHER**



→ INSTANT IMPROVEMENT >> USE ANGLES

If you look at actresses who know how to walk a red carpet, they turn their hips and legs away from the camera. That's because everyone takes a more flattering picture with their body rotated 30 degrees to either side. Also, if you can, shoot with the camera held slightly above eye level, at an angle looking down on the subject. Even better.

— ART STREIBER,
PHOTOGRAPHER



4

Know Which Ones to Fix

► Whether you happen upon a great sunset or Bill Murray at the golf course, sometimes the best approach is to take multiple pictures of the

same thing in the hope that one will turn out perfectly. But it's not always easy to spot the right one. A quick visual lesson:



Not only is the exposure better in the image on the right but it also has better framing. The fence, cars, and sign are distractions you don't want.



On the left, the sky is too bright and overexposed. You can't bring back those lost details. In the other shot, you'll be able to brighten the city and leave the sky as it is.



On the right, the guy in gray is the clear focal point, with a background that adds to the shot. On the left, he is just a blurry figure blocking the focal point behind him.

5

Get a Good Printer

► After testing the major print shops, we found their quality to be below what you can do at home. Plus, at home you can catch details that didn't show up on your monitor, fix them, and print again. The **EPSON SURECOLOR P600** (\$800) has a nine-color ink system that easily handles even the subtlest shading. It's a pigment printer, which is usually the better choice over dye.

Pigment rests the ink on top of the paper, while dye sinks in. Dye is slightly more vibrant, but unless you put it under UV glass, any exposure to sunlight will fade a dye image in a few months. Pigment-printed photos are rated for 200 years, even when on display.



6

And Don't Forget the Paper

► Let the subject dictate which type to use.

ACTION SHOTS: For sports or wildlife, use glossed paper. The finish accommodates a range of hues, making details extra sharp, and the reflective coating makes subjects in motion appear even more dynamic. One warning: The glare makes glossy paper bad for framing under glass. You'll want to mat them instead.

PORTRAITS, LANDSCAPES, AND BLACK-AND-WHITES: Use matte paper because it adds a slightly dreamy quality. It also absorbs dark colors and handles varying textures that can get lost in glossy prints.

GIFTS: It's too expensive to use all the time, but double-weight photo paper is more durable and has heft and significance.

THE LOST ART

Passing Around a Photo

It's rude to keep swiping the screen after someone hands you his phone to look at a picture. But not with printed photos. Whether on a wall, in an album, or rubber-banded in a shoebox, printed photos are to be perused. If you're welcome in that home, you're welcome to those photos. Those photos were printed with the expectation—a hope, even—that they would be shared. And if they are passed around to other friends, ridiculed, and maybe pocketed to be used at a later birthday or nuptials, then they will be shared with even more people, just as they should be. Don't let storing images on phones warp your idea of what memories are for. And certainly not whom.

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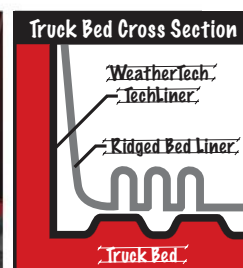
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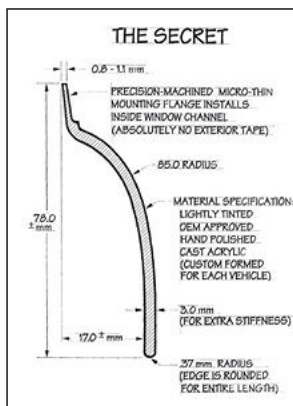
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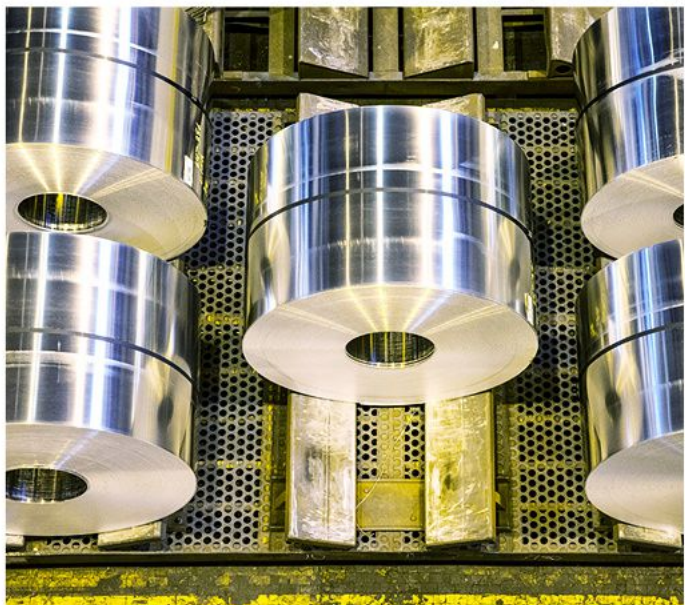
People said it was a gamble. A huge risk. Why take the best-selling vehicle in America and start over? Because Ford knew what no one else did: the aluminum-clad 2015 F-150 was a sure bet all along. This is how you make a revolutionary truck.

TOP ROW, FROM LEFT: A crane operator at aluminum maker Alcoa's Davenport Works; the F-150's tow graphics show whether the truck is level; an ingot rolls into the hot mill. Middle row: A lighter body means better gas mileage; scrap aluminum is 100 percent recycled; weighing in at a truck stop. Bottom row: Alcoa workers inspect the bed; the 360-degree camera is handy when you've got a twenty-foot trailer; rolls of high-grade aluminum.

PAGE

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You have to REMOVE YOUR WEDDING RING BEFORE YOU SET FOOT IN DAVENPORT WORKS,

the sprawling aluminum plant owned and operated by Alcoa, in Davenport, Iowa. You have to wear safety goggles and earplugs, a hard hat, and steel-reinforced metatarsal boots. And you're happy for your armor, because this place is the Midwest heavy industry of your imagination—135 acres of beautiful cacophony along the banks of the Mississippi River. At every turn there's a blast furnace disgorging molten aluminum, or a hot mill flattening ingots, or a sixty-ton crane motoring overhead, all of it making you feel eminently tiny and squishable. The machinery at Davenport never stops, because the gooey, metallic lava pouring forth from the furnaces will become a door or a hood, eventually the whole damn body of America's most popular vehicle. Ford has decided to make the body of the 2015 F-150 out of aluminum instead of steel, which is what the body of every other pickup truck is made of, and what the body of every F-Series, the best-selling pickup trucks in America for thirty-eight years running and one of the best-selling vehicles in the world, had been made of since the first F-150 rolled off the line in 1975. Last year Ford sold almost 740,000 F-Series trucks (the company does not break out individual sales figures), and there are an estimated 14.4 million F-150s on the road today. So when the Ford Motor Company decided to make the switch, Davenport Works got a lot busier.

I've come to Davenport not just to see how an F-150 is made but to help build a few more of them. Over at the loading docks sits a 5,000-pound roll of automotive-grade aluminum on a tandem-axle flatbed trailer. That trailer is hooked up to a 2015 F-150 King Ranch 4x4. Later today I'll fire up the truck and set a course for Ford's Dearborn, Michigan, stamping plant, where sheet aluminum is transformed into truck parts. I'll use an



F-150 to make more F-150s, because trucks are supposed to be handy, and Ford claims that the F-150's material metamorphosis makes it even more capable than its famously capable steel-bodied predecessor. With less of its own bulk to propel, the truck can haul more of whatever needs hauling—be it a boat, a load of mulch, or a 2½-ton hunk of high-grade metal.

Davenport is excited about the F-150, and not just because it brought new jobs and a major upgrade to the plant. This place makes the metal for a lot of cool stuff—the wings on Air Force One came out of this plant, Alcoa helped develop the all-aluminum chassis for the Audi A8, and it supplies armor for military vehicles—but the final product is often an abstraction to the people who work here. The F-150 is different. Half the trucks in the parking lot are F-150s. Out in the lobby there's a sign-up for an F-150 raffle dubbed "Lighten Up Already," with the "Al" rendered like the periodic table symbol for aluminum. The tickets are going fast.

After I have on all my safety gear, I climb on a golf cart with manufacturing director Rob Woodall. The golf cart is appropriate because Davenport's square footage is roughly equivalent to that of an eighteen-hole course under one roof. There's a network of roads inside, trafficked by forklifts and flatbed trolleys and employees riding industrial trikes just to get around. Mind the stop signs, because if there's something coming the other way, it'll probably be big.

They don't smelt aluminum at Davenport, but transforming recycled or new aluminum into a finished product still requires a lot of heat. A row of furnaces melt aluminum to be made into ingots, and each time a furnace opens up it looks like you're gazing into the molten bowels of the earth. The nearby pedestrian walkway is protected by plexiglass shields, lest a furnace's fiery exhalation relieve a passerby of his eyebrows.

THE COMPARISON:

ALUMINUM
ALLOY VS.
STEEL ALLOY

ALUMINUM IS:

▲	55%	THICKER
▼	45%	LIGHTER
●	30%	MORE DENT RESISTANT
▲	20%	STIFFER

Test sample: The F-150's tailgate panel



The ingots are dull bars of aluminum about sixteen feet long, 6½ feet wide—your future truck in its crudest form. The ingot's next stop is for hot rolling at the reversing mill, a machine designed to mash that ingot down to a few millimeters thick. They never really told me why I had to take off my wedding ring, but the implication was ominous, and watching the hot mill at work, I can only imagine what incident precipitated that rule. Woodall parks the cart next to the hundred-inch mill, which makes rolls of aluminum a hundred inches wide. "That's six stories tall," he says. I eyeball the structure. It doesn't look that tall. "Three stories of it are underground," he adds.

When an ingot goes into the mill, massive rollers pull it back and forth, a giant piece of taffy getting longer and thinner with each pass until it's a flat sheet that's rolled into a huge coil at the continuous hot mill. The coil cools, aided by towering fans. Then it gets cold-rolled, so it's thinner still. Coils at various stages of the rolling process sit on racks of pallets that seem to stretch for a quarter-mile.

After cold rolling the coils head to the new part of the works, the one that cost \$300 million, the point at which the primeval belching furnaces give way to brightly lit finishing lines. Here the coils are unwound yet again, heat-treated, and any wrinkles are pulled out. By now the metal is so thin and its surface is so smooth and pristine that a cushion of air supports the unwound sheet as it moves through the furnace before being re-coiled. The rolls, weighing between 20,000 and 40,000 pounds each, are loaded by crane onto eighteen-wheelers. Meanwhile other trucks are arriving with scrap metal to start the cycle anew. This whole process is also playing out at another huge plant run by Novelis, 800 miles away, in Oswego, New York. As massive as Davenport Works is, it's only half of the operation.

Alcoa's furnaces melt aluminum to be poured into molds that form giant ingots, bars that then go into the mill for rolling.

HERE'S THE THING about DRIVING THE 2015 F-150:

It's totally normal. That's what's so gutsy about Ford's decision to forgo steel, the metal of skyscrapers and battleships and Superman. The F-150 aluminum program is a hugely challenging and investment-intensive technical endeavor, a manufacturing and logistic reboot for the most important vehicle in America, and the benefits are invisible.

I'm heading east on I-80 towing the trailer, doing seventy, surfing the dial on SiriusXM, cranking up my heated seat now and then. After about thirty seconds behind the wheel, you forget that your pickup, with its aluminum body and twin turbos, has more in common with a Bentley than it does a Silverado. What Ford did is akin to building a house with a blast-proof foundation—you know it's important, but it's not as overtly flashy as blowing your budget on a BlueStar range and a liquor-stocked panic room.

You can tell that Ford is a little bit conflicted about how to promote its move to aluminum. They want to make a big deal out of it while simultaneously reassuring truck buyers they haven't done anything too radical. Ford's "Forward March" TV spot features Denis Leary growling about the new truck's aluminum body, yet the word aluminum is conspicuously absent from the F-150's window sticker—the list of features includes "fully boxed steel frame" yet makes no mention of that revolutionary body. If I were in charge at Ford, I'd offer the F-150 with no paint, like an Airstream trailer or a polished 747 fuselage. Loud and proud.

Aluminum costs more than steel, on a per pound basis. Repairing it—and thus insuring it—might prove a little more expensive too. But its advantages are huge. Aluminum doesn't rust. It can absorb more crash energy than steel. And—the main reason for this whole grand exercise—it's lighter. Even though a 2015 F-150 fender is thicker than a steel counterpart, it weighs 55 percent less. Depending on the trim, 2015 F-150s lose as much as 700 pounds compared with the 2014 model.

Given the same power, the new truck is quicker, it handles better, and it stops shorter. Most importantly, it uses less fuel. And even if that improvement works out to only two or three miles per gallon across the board, millions of these trucks could hit the road over the next few years. A little quick math suggests that the aluminum F-150 will save a billion gallons of gasoline within five years. By comparison, the Chevy Volt—an engineering feat in its own right—has saved more than 36 million gallons, according to OnStar data collected from cars. Electric cars are great, but if you really want to dent the national demand for crude,

THE F-150: A BRIEF HISTORY



1970s
A 460-cubic-inch V-8 gave this generation an edge over most other trucks.



1980s
The Twin Traction Beam front suspension is still controversial.



1990s
1997: overhead-cam V-8s and real independent front suspension.



2000s
The F-150 adopts the big-rig styling that endures today.



Left and center: Freshly stamped F-150 parts—door frames, fenders, hoods—wait to be sent to Ford's Dearborn Truck Plant to be assembled into the lightest full-size truck body on earth (right).

FORD'S ROUGE COMPLEX looks like A SET FOR THE CLIMACTIC BATTLE OF A JAMES BOND MOVIE:

It's a massive, imposing tableau of smokestacks, warehouses, and rail lines, the guts of the American car industry. Dearborn Stamping, located within, opened in 1939, and parts of the exterior haven't changed since. Shortly after I pull through the brick arches of the Rouge Complex

entrance, a train rumbles past dragging flame-belching cauldrons of molten metal into the adjacent AK Steel plant. Steel isn't going away anytime soon, but the stamping plant next door is devoted to the aluminum future. I park the truck and head in to meet the people who are tasked with reinventing the F-150, including a contingent from Novelis, which, along with Alcoa, helped devise Dearborn's elaborate scrap-recapturing system.

"We didn't just wake up yesterday and decide to build aluminum F-150s," says George Luckey, Ford's technical expert for advanced engineering and manufacturing processes. "We've been working on this for years. It goes back to when Ford owned Jaguar and built the aluminum XJ. Manufacturing that car taught us things that are relevant to the F-150."

Of course, trucks present challenges that don't show up on Jags. For instance, early prototypes used steel rivets on the bed. When the bed got scratched up, the aluminum wouldn't rust but the rivets would turn into ugly orange warts. The solution: Replace the rivets with spot welds and adhesives.

Dearborn Stamping engineering manager Jason Blosser leads us down to the spotless manufacturing floor, where coils of aluminum await their trip into the presses. The presses themselves are housed in what look like free-

you need to start with the trucks.

This truck, a loaded four-door King Ranch, epitomizes the all-things-to-all-people role that pickups play in America. It's a luxury car, with heated and cooled leather seats, adaptive cruise control, and power-deployed running boards that pop out when you open the door. It's a family sedan, with seating for five and cup holders aplenty. The 3.5-liter EcoBoost V-6 makes 365 horsepower and 420 pound-feet of torque, enabling a fair impression of a muscle car. And, yes, it's a workhorse—four-wheel drive, locking rear differential, and a decided indifference to the 7,000 pounds or so hitched to the rear.

Although the F-150 is the lightest full-size truck, with a curb weight starting at a mere 4,050 pounds (compare this with the previous F-150's 4,745 pounds), my truck-and-trailer combo is just shy of 13,000 pounds. I know this because I weigh it on a scale at a truck stop near Ottawa, Illinois. The fact that the V-6 is dragging more than six tons at seventy miles per hour explains why I'm getting ten miles per gallon. Which brings me to some advice for the F-150 shopper: A twenty-three-gallon gas tank doesn't take you far when you're towing. And stopping for gas is exponentially more aggravating when you have to navigate a trailer past the pumps. My kingdom for the optional thirty-six-gallon extended fuel tank!

After a little more than seven hours on the road, I pull into the parking lot of the Dearborn Inn, which was built on Ford property in 1931. Tomorrow morning I'll drive a few minutes down the street to the Dearborn Stamping Plant, where this truck's body was created from a roll of aluminum just like the one I brought from Davenport.



THE SMALLEST F-150

You don't expect much out of a kid's toy sold at Walmart, but let me tell you: The Power Wheels F-150 is pretty unstoppable. The secret? Monster Traction, which is Fisher-Price's term for what amounts to an electronic locking differential. After watching my 4-year-old motor out of an old golf course sand trap, I asked Fisher-Price how it works. In high gear (the five-mile-per-hour setting) the two motors at each back wheel are wired in parallel, with a hundred percent of the battery voltage. So if one motor loads, it gets more current, meaning power goes to the tire with traction. It works so well, my maniac kid drove it up a tree trunk and flipped over. Maybe the next generation should have a roll bar.



standing garages, with rail tracks leading to vast doors on each side. This is so the dies can be quickly swapped out when you want to switch the line from making, say, a fender to a tailgate. The doors have windows, so you can walk right up and watch the magic as sheets of aluminum go in one end and truck parts come spitting out the other side.

First the metal is precut to the rough dimensions of whatever part needs to be made. That stack of blanks goes into the press. A many-tentacled robot uses suction cups to grab a piece of aluminum and place it in the press. Smash! Now it looks like a fender, and the suction cups grab it and move it down to the next die, which crashes down again and refines the shape. “For steel we used electromagnets to pick up the parts,” Blosser says. “That obviously wouldn’t work with aluminum because it’s nonferrous, so we had to go to the vacuum system.”

I walk around to the output end of the press, where F-150 fenders are dropping onto the conveyor belt like Everlasting Gobstoppers pouring out of Willy Wonka’s chocolate factory. Workers grab the fenders off the belt, inspect them, and place them on racks. They’re slinging those fenders around like they don’t weigh anything at all. “When a bed is fully assembled, tailgate and everything, you can lift it off the ground with one hand,” Blosser says. Yet the parts are stronger than steel—depending on the chemical makeup of the alloy, aluminum can be the Reynolds Wrap around your sandwich or the armor on your MRAP. Ford’s stuff is closer to the latter. The alloys have improved a lot since the company started building prototype aluminum Tauruses in the early nineties.

Out here on the main floor we see the trucks taking shape, but in the basement is where you find a big piece of the business case for the aluminum F-150. As each part

is stamped, the excess metal drops down a chute into a shredder. Downstairs a one-hundred-horsepower fan blows the sorted scrap into tubes that run outside the building and into waiting eighteen-wheelers that return it to Oswego or Alcoa’s Tennessee plant for recycling. This is a major reason why the aluminum F-150 makes financial sense for Ford: zero waste.

“It takes about ten times more energy to smelt aluminum than it does to start with recycled scrap,” says Derek Prichett, global head of recycling for Novelis. So capturing the scrap is hugely important. And not just from a monetary standpoint but because the F-150 production requires so much. “On a typical automotive program, say you’re making a hood or something, you might need 10 million pounds of aluminum per year,” Prichett says. “With the F-150 . . . they’ll need 800 or 900 million pounds a year. That’s why there are two main suppliers. Neither of us on our own could handle it all.”

All this effort—years of research, billions of dollars, new infrastructure from New York state to Iowa—all so that the F-150 could gain a few extra miles per gallon. Ford took the lead to do the hard thing, forging a path that might not reap immediate rewards. After all, the F-150 probably would’ve remained a best-selling truck whether they made it out of aluminum or pig iron. Ford could’ve dangled a bright shiny object—a small diesel engine or trick new transmission—and won plaudits without really changing anything. Instead they went lightweight, engineering a force multiplier that will leverage all subsequent improvements—diesels, hybrids, ten-speed transmissions—to maximum effect. The new F-150 is the payoff for a plan years in the making, a machine of which Ford should rightly be proud. But it’s also just the start. This is the foundation. ■

THE CONTRACTOR’S VERDICT

TOM LYNN IS A BOSTON CONTRACTOR WHO DRIVES A 2006 F-150. WE GAVE HIM A 2015 F-150 2.7 ECOBOOST 4x4 AND TOLD HIM TO PUT IT TO WORK. HERE ARE HIS THOUGHTS.

Small contractors often use their truck cab as their site office, and Ford obviously understands that. I love this cab. The console file cabinet is genius, and the plugs for computers and phones are in a compartment that neatly stores all of the wires. I’m actually writing this in the truck.

In terms of power, the 2015 felt about the same as my V-8-powered ‘06, but the fuel mileage is unreal. I’m certain that I used less than half the gas I would have in my old truck. The way the stop/start engine shuts down at stoplights was weird at first, but it was never a problem, and the added fuel efficiency makes it worth it.

The bed works really well for the kind of jobs I do. The spray-on liner is awesome. I spill things, carry debris, and slide tools in and out all day. With this liner, you don’t worry about scarring up the bed. The remote-locking tailgate is very nice too. I usually use a tonneau cover over the bed and the ability to easily lock and unlock the tailgate is an asset.

The drop-down tailgate step is kind of cool, but it’s another thing to break, and I’d probably prefer not having it. The plastic cover over the step came loose when I was unloading a snowplow. I drove the truck during the endless Boston blizzards, so I can vouch that it performs well in very deep snow. The wiper blades stay thawed, which isn’t always a given.

Finally, this truck is a babe magnet. I’m old enough that the women aren’t looking at me, but I’m sure I could have gotten a date with this truck. Let me know if you need a contractor’s thoughts on a Maserati.





THE
SCIENTIFIC
COMPANION

T O R A

LODGEPOLE, NEBRASKA, JUNE 2012



A COMPREHENSIVE GUIDE TO UNDERSTANDING AND
SURVIVING ONE OF NATURE'S LEAST PREDICTABLE-AND
MOST DANGEROUS-PHENOMENA.

PHOTOGRAPH BY CAMILLE SEAMAN



HOW THEY START



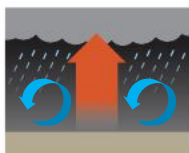
THE FORMATION

With thanks to Greg Carbin at the National Weather Service.



01

Warm, moist air, usually from the south, is lifted by a warm or cold front, causing an updraft. The moisture condenses into clouds and precipitation and forms a thunderstorm.



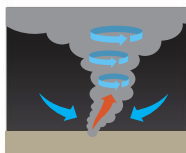
02

Precipitation should counter the updraft, but when winds blow precipitation out of the rising air, the updraft strengthens. Beneath the storm, winds of different speeds (shear) form horizontal tubes of rotating air.



03

When those tubes are ingested into the updraft, they become vertical and the storm acquires rotation, forming a supercell.



04

The rotating tube is stretched, and the supercell becomes like a giant vacuum, sucking air up and away. As air rushes in to equalize the pressure, a tornado is formed.

DISASTER PHYSICS

HOW A TORNADO THROWS A CAR

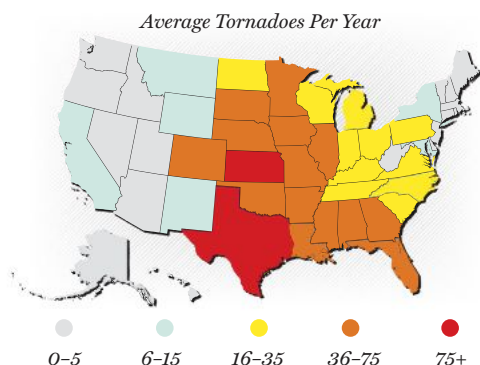
It's the same principle that gets a 747 off the ground: Intense winds flowing over the top of a car create aerodynamic lift, in which there is less air pressure above than in and under the car. Once the car lifts, the winds get underneath it and raise it higher or just slam it around. The strength of the forces applied to the car grows with the cube of the wind speed. So if the wind doubles in speed, it exerts eight times as much force on the car.



A FEW FACTS ➔ On average, Texas has the most tornadoes each year, at 155. // Florida has the most tornadoes per 10,000 square miles, followed by



GURLEY, NEBRASKA, JUNE 22, 2012



TORNADO COUNTRY

Tornadoes can form anywhere, at any time of year, but most occur between April and July, either in the Southeast or a swath of the Midwest that rises from Texas to South Dakota.

THE RATINGS

Tornadoes are categorized by wind speed, typically determined after the fact, through damage assessments. The Enhanced Fujita Scale, or EF, is named for Dr. Theodore Fujita, a storm researcher at the University of Chicago.

EF0

3-SEC GUSTS OF 65 TO 85 MPH.
63 percent of tornadoes are EF0 or EF1.

EF1

3-SEC GUSTS OF 86 TO 110 MPH.
Can push a shed off its foundation. EF0 and EF1 storms cause less than 5 percent of all tornado deaths.

EF2

3-SEC GUSTS OF 111 TO 135 MPH.
Can destroy building walls and roofs.

EF3

3-SEC GUSTS OF 136 TO 165 MPH.
Marked by thicker funnels. Along with EF2, accounts for 35 percent of tornadoes and 30 percent of deaths.

EF4

3-SEC GUSTS OF 166 TO 200 MPH.
Only 2 percent of tornadoes reach EF4 or EF5.

EF5

3-SECOND GUSTS OF OVER 200 MPH.
With EF4, accounts for 65 percent of deaths. Winds can twist twenty-story buildings.



THE CHASERS

EMILY SUTTON

OKLAHOMA CITY

WHAT'S SO INCREDIBLE about tornadoes is that they're beautiful and destructive and mysterious. It's surreal. You feel panicked, excited, scared, and heartbroken, all at the same time.

I was in the path of the Moore, Oklahoma, tornado on May 20, 2013. We were slamming south on the highway, and when we pull off at an exit, we're staring at an EF5 bearing down on the town. It looks fake, almost like a backdrop. Then you see debris floating around it in a way that feels peaceful, like a snow globe. Then all of a sudden your heart sinks because you realize that people are dying. You feel guilty, because it's inevitable that people are going to die, and there is nothing you can do. There are homes, cars, and people being thrown in front of you at that moment.

We rushed straight south and got out of its path, and then I felt debris falling from the sky like rain. It was black in front of me. I'd never seen that before. We watched the storm eventually rope out, but at that point we didn't know what had happened because the phones were out.

When another storm chaser, Tim Samaras, died ten days later, I was only a mile down the road from him. It really reminds you of the power of nature and how tornadoes need to be respected. Just because we have all of these fancy gadgets, that's not going to protect you.



HOW TO FIGHT THEM



THE CHASERS

SEAN CASEY

LOS ANGELES

EVERY TORNADO HAS a different sound. A normal-size tornado going over farmland will sound like you're next to Niagara Falls, with a constant roaring. But when a tornado goes over a town and starts picking things up, it becomes more of a rumble. You're hearing noise from all the debris that's aloft. Then you have these little sub-vortices, these powerful little spin-ups that happen quickly, all around you. When one of those little vortices forms, it makes this hissing sound. It's so dang spooky.

The first tornado we ran into with the TIV [Tornado Intercept Vehicle, which Casey created to plant directly in the path of tornadoes], we could see the funnel forming at the base of the storm. Two or three miles to the south, we saw swirls. That circulation was starting to manifest itself on the ground with dust kicking up, but there was no actual condensation tube. We decided to drive for it, thinking it was going to strengthen before we got there, but when we got there, it had actually weakened. Those little dust swirls were gone, and it was like when you're on a boat, and you see the shark's fin, then it submerges. Suddenly all that reddish-brown Kansas dust just exploded. It went all around us until we were completely blind. You couldn't even see the ground, and you could barely see out the window. It was like we were getting sandblasted. The only things visible were the telephone poles next to the road, so we used those to navigate out of there, all while going in reverse. This was a little dirt road, so you're not doing a ten-point turn.

There's just nothing like being underneath these supercells. The sky comes alive with violence and beauty, and you're immersed in it. You have a visual mountain over you. After all these years, they still seem like they just shouldn't exist. You're witnessing a monster.

THREE CRAZY WAYS TO PREVENT TORNADOES

Tornadoes release built-up pressure in the atmosphere.

If we could eliminate them, the atmosphere would have to find another, possibly even more destructive, form of release. But that hasn't stopped people from trying.

Tornado Walls

Theory: Walls 1,000 feet high and 150 feet wide would disrupt the air movement that allows tornadoes to form. Problem: A simulation found that the walls needed to be more than 8,000 feet high to be effective.

Microwaves

Theory: Removing the cold air of a tornado by heating up the storms with microwave-shooting satellites.

Problem: Supercells generate energy on the scale of nuclear warheads. Which would get a little expensive.

Cloud Seeding

Theory: Seeding a developing storm would cause dissipating precipitation. Problem: You can't prove that a storm acted the way it did because of seeding, so there is no way to prove its efficacy.

THE NEW TECHNOLOGY

01

A More Targeted Warning System

Traditionally, whether a tornado shows up one mile away or thirty, if it's in your county, a siren goes off. But rarely is an entire county at risk, which means that people become accustomed to hearing the siren without seeing a tornado. After a few false alarms, it's easy to stop taking the sirens seriously. To combat this, in 2007 the National Weather Service began targeting polygons, geographic areas as much as 80 percent smaller than entire counties. But many counties didn't have the necessary technology, and county-wide sirens continued. WeatherWarn is a simple solution: a software-based siren controller that automatically activates the correct sirens. It also works with smartphones and social media for areas that are not covered by sirens.

02

A New Doppler

The Doppler radar system used by the weather service since the 1990s had a limitation: It was one-dimensional. The microwaves it sent out were all oriented horizontally, which meant the system could determine if precipitation was light or heavy, but it could not tell you if that precipitation was rain or snow. In 2013 the weather service upgraded all its equipment to dual-polarization Doppler radar, which uses microwaves oriented in both directions. Coupled with enhanced computer processing to handle the additional data, the weather service radar system can now determine the size and shape of exactly what is in the air.

03

The Power of Sound . . .

Because radar works by bouncing off things, it's hindered when hills, trees, and other nonweather objects get in the way. As an alternative, infrasonic arrays measure super-low-frequency sounds, such as the signature wind action of tornadoes. Those sound waves

thunderstorms generally need the heat of the sun to form, and tornadoes need thunderstorms. // Since records started being kept in 1980, 2011 was the most expen-



can travel very far, allowing severe storm activity to be observed from more than 600 miles away.

04

... And Lightning

Research suggests lightning occurs frequently in developing tornadoes, so scientists are using networks of electrical sensors called Lightning Mapping Arrays to measure the radio-frequency impulses generated by lightning. By pinpointing lightning's location, data can be returned in as little as one minute, as opposed to five to ten for radar.

05

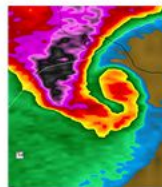
The Simulator

In 2014 Leigh Orf, a professor of atmospheric science at Central Michigan University, and his team presented the first-ever 3D simulation of an EF5 tornado. The simulation provides a way to study a storm in great detail and from any perspective, which cannot be done with live storms. The better you can understand a fake storm, the easier it is to predict a real one.

HOW TO SPOT A TORNADO

ON RADAR

DOPPLER SENDS OUT microwaves that bounce off objects, reporting reflectivity (the presence of weather) and velocity. The first indicator is a hook echo (pictured). On a reflectivity map, it shows up as a hook-shaped formation at the storm's southeast corner, opening toward the east. That signifies precipitation wrapped around a column of warm air. The second sign is a velocity couplet. On a velocity map, you'll see winds moving away from the radar adjacent to winds moving toward it. Because radar typically displays away movement with red and toward movement with green, this looks like adjacent red and green coloration—like Christmas lights. When both a hook echo and a velocity couplet appear on radar readouts, it doesn't necessarily mean there will be a tornado, but it does mean it's time to put out a warning.



*With thanks to Steven DiMartino at
nynjpaweather.com.*

ON LAND

THE FIRST SIGN IS THUNDERHEADS: puffy cumulus or cumulonimbus clouds. The wall clouds and funnels will form right beneath them, so check there for any organized rotation. Watch the storm base closely, and look for persistent lowered areas—the lower they are, the better the chance of a tornado. Another good sign is if the winds are warm and blowing toward that base. Look for any motion or quick changes around a flat, lowered area protruding from the storm base, called a beaver tail. Watch the terrain beneath the funnel cloud for any dust or debris that gets kicked up, or for rapidly moving cloud filaments along the ground. In some storms the lightning and thunder will get close, frequent, and loud for five minutes, and then just shut off. That's when the storm gets serious about making a tornado.

With thanks to William Reid, storm chaser.

sive year in terms of damage caused by tornadoes, at \$28 billion. // April 27, 2011, holds the record for the most tornadoes on any single day. There were 199. ➔



HOW TO SURVIVE



WASHINGTON, ILLINOIS, NOVEMBER 18, 2013

THE SAFE PLACE

BY KIM CROSS

COLD FEAR SPIDERS DOWN the length of my spine every time the siren screams. The wail sounds like a World War II air-raid siren, and it means a tornado has touched the ground somewhere inside my county. The weather radio crackles to life, dispatching warnings in a droid-like monotone. On TV the weatherman waves in front of a radar screen blooming with angry spirals.

Sometimes we can see it live, on a SkyCam, a writhing funnel shredding houses and lives as the rest of us look on. When the power dies, that image lingers. The lights wink out, and the comforting hum of household things gives way to a terrible silence—a stillness that's absolute.

We grab headlamps and sturdy shoes, in case we have to walk on rubble later. By battery light we pluck our 7-year-old son from the warmth of his bed, gather blankets and soft pillows, and call our dog into the tiny laundry room at the bottom of the stairs. We pull a bike helmet over our sleeping boy's

head, and buckle our own. We get the mattress from his bed, huddle under it in the dark, and wait.

It is as helpless a feeling as I've ever known. A primal fear, knowing danger is close and there's nothing you can do about it. Tornadoes are acute and erratic, leaving one house inexplicably standing between two bare foundations. It doesn't matter who you are or what you've done. The center of your world is asleep in your arms, and his fate will be determined by how the wind decides to blow. We could be sucked into the sky and pummeled to death with the bricks of our well-built home. We could be thrown hundreds of feet, impaled by a mailbox, or crushed by falling walls. We could suffocate slowly under a mountain of debris. *We could die.* Or, worse, some of us could live in a world without the others.

Kim Cross is a writer living in Alabama. Her new book, What Stands in a Storm, chronicles a tragic three-day tornado outbreak in 2011.

THE RESCUE APP

After a devastating 2013 tornado in Moore, Oklahoma, left rescuers struggling to account for survivors, fireman Shonn Neidel and his brother-in-law Dan McIntyre built an app called Pinpoint Storm Shelter that catalogs all storm shelters, along with a description and the number of people expected to be inside. (Homeowners register the location and likely occupancy of their shelters when they apply for the necessary permit.) Using the app and the GPS on their devices, searchers can go to the exact location of a storm shelter, even if it's buried under debris. The app also allows shelters to be checked off as they are searched, making it easier to coordinate search and rescue efforts, even with volunteers who aren't familiar with the city.

TYPES OF SHELTER

In decreasing order of effectiveness

MOST EFFECTIVE



Basement



Interior room with no windows



Ditch



Mobile home



Car



Highway underpass


LEAST EFFECTIVE

WEATHERMAN JIM CANTORE CHASES TORNADOES. ALONG WITH HURRICANES, BLIZZARDS, STORMS, AND SQUALLS.

To learn about him and his disdain for parking tickets, keep reading.

// The fastest winds measured in a tornado were 318 mph. // The average tornado moves at 27 to 29 mph. // The average warning time for a tornado is only 13 minutes.

The Storm Chaser



BY
ALLISON
GLOCK

PHOTOGRAPHS
BY TONY
LUONG

PAGE
67

NO ONE REVELS IN THE HARSH AND BEAUTIFUL SCIENCE OF CLIMATE MORE
THAN **JIM CANTORE**, THE WEATHER CHANNEL'S FRANCHISE
ANCHOR. IF HE SHOWS UP IN YOUR TOWN, IT MIGHT BE TIME TO BOARD UP
THE WINDOWS, FILL UP THE TUB, AND FLIP ON THE TUBE.

There is nothing in this vast universe that meteorologist Jim Cantore loves more than thundersnow.

There may, in fact, be nothing anyone in this vast universe loves more than Jim Cantore loves thundersnow—which, as the name suggests, is the simultaneous appearance of two distinct meteorological features, a phenomenon that takes place in just 0.07 percent of all storms. One video clip, captured in February in Plymouth, Massachusetts, shows Cantore's ice-slathered face looking momentarily stunned when lightning flashes amid the snowflakes, then he begins screaming, "You gotta be kidding me! Yes! Yes! Yes! You can have your \$500 million jackpot in Powerball or whatever the heck it was, but I'll take this, baby!" while he leaps and attaboy-pumps his arms. To watch Cantore in this sort of rapture is to watch a man bursting with an ecstasy so complete you begin to feel a bit embarrassed, like you've caught him unawares in the throes of passion, a man liquefied and consumed, his very being blown to particles by the weather equivalent of the money shot.

Thundersnow Jim is something of a television phenomenon, someone whose gyrations have made him so beloved to millions of television and weather watchers that over the past decade he has become the face of The Weather Channel. Mere hours after his latest thundersnow histrionics, the channel was already featuring the footage in an ad as its slogan, "It's amazing out there," floated onscreen.

Well, amazing for Cantore, anyhow. Outside of television, in the realm where people have to find their way to work in twenty-five inches of snow or deal with the sudden absence of their roof, the weather can seem less beguiling. Cantore knows this, and for the past three decades he has made a living advising people when and how to cope with myriad unfortunate circumstances, often from the site of the disaster. His presence is so synonymous with severe weather that Weather Channel president David Clark jokingly calls him "the face of impending doom."

In late January, Cantore joined mainstay Sam Champion as coanchor of *AMHQ*, the newly revamped morning

show that is The Weather Channel's most watched program. He wound up making his predawn debut from the streets of Boston, where he was reporting on a blizzard that dumped more than two feet of snow. That would begin a stretch in which he would, over a period of a couple of weeks, make it home for just one twenty-four-hour period, after which he would fly to Virginia Tech to film a segment, then immediately catch another flight to Massachusetts for yet another onslaught of snow.

That, lumped together with all he has seen and experienced—the devastation of Katrina and Sandy, the constant moving toward things everyone else is running away from—can seem thrilling and energizing, but also something more. Even for Thundersnow Jim, that kind of grind could just get . . . *exhausting*. Enough to make you wonder what keeps Cantore going.

JANUARY 27, 2015,
4:02 A.M.: CANTORE
STANDS ON THE
EDGE OF BOSTON
COMMON, ALONE
WITH HIS SNOW.



CAN YOU BELIEVE THIS WEATHER? OUR FAVORITE NATIONAL OBSESSION, BY THE NUMBERS ➔ **\$999:** Cost of a typical high-end personal weather



CANTORE IS CLAMBERING into his Toyota Tacoma when he spies the yellow ticket tucked under the left wiper blade. “What the?” he mutters, craning a thick arm out and around the windshield, stretching to pluck the citation like he would an errant weed. It’s a couple of weeks before the Boston blizzard, and Cantore has just finished several hours of morning-show rehearsal. His mood isn’t great. He started his career at 22 on the dawn shift, a brutal schedule he was happy to trade in for intimate brushes with hostile weather events—and now it’s sinking in he will need to start rising again at 3 a.m. for work, which doesn’t thrill him. Nor is he particularly psyched about being asked to bring the perky persona (wearing a dress shirt no less) that viewers expect from morning hosts. But mostly he is really annoyed about the parking ticket he now clutches in his

hand. Cantore squints at the ticket, snarls slightly.

“Screw it,” he says after a beat, then wads up the paper and tosses it out the window. He turns and grins. “Let’s get the hell out of here.”

Cantore pulls out of the lot and speeds down a road outside The Weather Channel’s Atlanta headquarters. “My job is to explain the facts to the public,” he says, sailing through a red light. “If there is a big weather outbreak, it’s like game day. How can I communicate this message? My tone? Are people going to all of a sudden go, holy shit, he is serious! Maybe I need to pay attention.”

Cantore speaks of his time in front of a camera as his “burden of responsibility.” He likens his job to being a fireman. There when you need him. Ready with a plan or escape route. Over the years his cachet has grown to

the point where he sometimes usurps state and local governments as the source of information and advice when a storm lands. And in January, city officials in Boston asked for updates on forecasts and precipitation totals—and he didn’t hesitate to share what he knew. That wasn’t the first time that had happened.

“I take weather pretty serious,” Cantore says. “Let’s face it, you can mix in entertainment, beautiful people, but at the end of the day, it is a service.”

Clark says Cantore has nurtured that ethos at the network: “He’s seen as a protector of sorts. He feels like he’s part of an army doing a larger job, and there’s kind of a code that comes with that.”

Which is maybe why he seems a little stilted during dress rehearsals on the *AMHQ* set, wearing a fitted maroon button-down instead of the L.L.Bean windbreakers and baseball caps he usually sports in the field. As the rehearsal wraps, Champion pulls Cantore aside, explains he held back on the forecast numbers because he wanted to let Cantore deliver the statistics. “I’m passing you the baton.”

Cantore nods. “That’s the home run,” he says. “The stats.”

“We’re covering weather like no one else can,” Champion says, giving Cantore an affectionate dap on the shoulder. Still, Cantore looks a bit awkward forcing banter with him and the show’s other regular meteorologist, Jennifer Delgado.

Later, over lunch, Cantore says he lacks patience for what he calls fake small talk: “I’m my own boss in the field. No one is telling me what camera to look at. It’s just me and the friggin’ weather, you know?” He jabs at his salad with his fork,



station (PWS) // **33,000:** PWS owners in U.S. reporting to Weather Underground (WU) // **475:** Gigabytes of data sent daily from personal stations to WU





HIS RESEARCH IS EXHAUSTIVE, BUT HIS REPORTS ARE AD-LIB. THE SKY "PUKES SNOW."

Cantore gets our desire to watch the storm roll in even as we know what it might cost us.



AS MUCH AS THE WEATHER is a source of joy for Cantore, some experiences haunt him. Covering Katrina, he and his team were stationed in Gulfport, Mississippi. It was the first time he had "seen and smelled death," and he was ill-equipped for the devastation. They spent eighteen days immersed in the ruin. "It was a bad scene," he says. "I saw casinos sitting in the middle of the frickin' highway. Boats four stories up in buildings. Imploded."

Even worse was the aftermath. "Everyone is spilling their guts. They just lost everything, and you feel awful because you can't do anything except talk into the camera, 'Back to you.' It's like, fuck this, I just wanna grab a chainsaw and help these people get out. I was numb when I came back."

Cantore knows the odds are he will witness another Katrina. Possibly worse. He recites the facts: escalating temperatures, the atmosphere's CO₂ concentration clocking in at over 400 parts per million, rising sea levels. "Storm surge starts there," he says. "That's where the game gets played. We've built onto the coasts everywhere. And now that we're seeing more and more hurricanes, we realize, oh shit. A Sandy in Miami?" He shakes his head, eyes wide as poker chips.

In some ways The Weather Channel is the only true reality television left, the one remaining chunk of programming that cannot be modified to suit a desired narrative. And what makes Cantore so watchable is not so much that he can digest and report a forecast but that he inhabits the same space we all do: the discombobulating territory between shock and awe. Watch his past appearances on *Storm Chasers* and you can see it in his face as he watches twisters tearing up the landscape—that blend of thrill and dread. Cantore understands our innate desire to court fear, to watch the storm roll in even as we know what it might cost us, to categorize and measure the forces that dwarf us. He knows, too, that the only course of action that remains for viewers—and the rest of us—is to adapt, to do what we can for one another.

the sound startling.

The eldest of four adopted children, Cantore was raised by postmaster father James and stay-at-home mom Betty. The family lived in a Victorian farmhouse in Craftsbury Common, Vermont. As a kid, Jim could often be found doing chores, especially in the garden. He liked the way hard work made him feel.

When he was 16, Cantore awoke one day with the notion to pedal his ten-speed to Rutland and back—eighty-four miles of mountainous road. "I think he just did it to prove to himself he could," says his brother Vincent.

Studying meteorology at Vermont's Lyndon State College, where friends called him Rocky because of his resemblance to Sylvester Stallone, Cantore found an outlet for his high-voltage wiring: He loved being in front of the TV camera. Cantore got several job offers after graduating, but opted for The Weather Channel in 1986 and never left. "They tried to shape me in the beginning," he says, "but what you see is what you get with me. People don't realize it's all ad-lib. There's no teleprompter telling Jim what to say." (Speaking in the third person is not a rare occurrence for Cantore, who also calls himself the Can Man, among other monikers.) "Everything I do is off the cuff. What I'm feeling, what I think people need to know."

Cantore shrugs. "Look, on a sunny day, when nothing is going on, I'm not your guy," he says. "Sam's great at that. But when the game is on the line and the shit is hitting the fan, I want the ball."



Before he covered his first storm, in 1992, he extended a three-day forecast to five days, Cantore says. No one had done that before with a hurricane. Seconds after Cantore got off the air, a producer handed him a phone, saying Bob Sheets, then director of the National Hurricane Center, was calling. “I thought they were joking with me,” Cantore says. “Then I heard his voice, and I thought, oh shit.”

Sheets asked Cantore if he’d lengthened the Hurricane Andrew forecast. “I told him, ‘All I said was, if it keeps going in this direction, everybody from the Outer Banks to Florida needs to pay attention.’ And he yelled, ‘Don’t do that again! I’ve had every emergency manager up the entire East Coast calling me!’”

Cantore apologized, but he realized something for the first time: People were watching.



ON THE MORNING OF his *AMHQ* premiere, ensconced in Boston, Cantore provides updates on what will become several weeks of record snowfall. Liberated from the set, his joy is palpable. Between takes he goofs around on snowshoes, tweets photos of himself eating a hunk of compacted snow like it was a foot-long sub. On air he is both energized and stern in his admonitions to stay off the roads. He litters his reports with bro-speak: *jacked, crushed, pumped, amped*. The sky doesn’t flurry, it “pukes snow.” But between takes, he retreats to the van to study what is coming next, to focus on how he can help people plan, what he can tell them that might provide some relief.

Cantore calls me on his way to fly to Virginia Tech after his brief stop at home. He sounds a bit subdued. “Quite frankly, these last three weeks are killing me,” he says. “I’m crying uncle. Actually, I’m on my fifth uncle.”

The weather will eventually settle for a spell, and during these types of interludes Cantore tries to escape to his cabin in the mountains of northern Georgia. He chops wood. He builds fires. He plants Japanese maples. Divorced since 2006, Cantore often takes his kids, Christina, 21, and Ben, 19. Both were born with Fragile X syndrome, a neurological disability akin to and often overlapping with autism. “At first I was pissed,” Cantore says of the diagnoses. “Once I accepted that some things are going to be easy and some aren’t, it got better.”

Cantore takes fatherhood as seriously as he does his forecasting. When ex-wife Tamra was pregnant with their first child, Cantore reached out to his own birth mother via the adoption agency. But when they located her, she chose not to reconnect. “The agency said, ‘Well, Jim, unfor-

tunately about 15 percent of the time, parents don’t really want to acknowledge the situation, and you are one of those 15 percent.’” He shrugs. “It hurt then. Not anymore.”

Cantore is used to swallowing his feelings. It comes with the job. He tries to fully reckon with one storm before moving to the next. People count on him.

The sun is setting as he pulls his truck into the airport lot, gathers his bags. Strangers ask where he’s headed. He answers patiently, then turns his attention back to our conversation. Why does he love the weather so much? “Simple,” he says. “It’s the one thing I can’t control.”

Cantore tells me that the way he sees it, “There is no tomorrow.” There is only now. This day. This moment. And in this moment, there is a giant storm brewing up north, and he intends to fly headlong into it. ■

✕ THE WEATHER WARRIOR

When Lt. Col. Joe Benson ventures behind enemy lines, his objective is to answer one question: How’s the weather? As a member of the Air Force’s Special Operations Weather Team (SOWT), he collects and analyzes weather data for special-ops missions. Here, he explains.

Popular Mechanics: Are you a weatherman, a soldier, or both?

Joe Benson: A SOWT [“sow-tee,” like “cow”] is both a special operator conducting risky missions and a forecaster. We do reconnaissance in politically sensitive or nonpermissive areas to gather data on all aspects of the environment: river conditions, beach/surf zones, alpine snowpack, and so on. A commander needs a SOWT to answer the questions, can the mission go or not? And if not now, then when?

PM: So you know the special-ops mission in advance?

JB: You have to know which assets—helicopters, transport aircraft, drones, small boats, large vehicles, ATVs—are part of the mission, as well as the timing and sequencing of those assets.



That helps you determine how the environment may impact the mission. For instance, low, thick clouds impact a drone’s ability to see targets below.

PM: You’ve had lots of territory to cover lately.

JB: I set up some of the earliest sensors across Afghanistan. In June 2002 I met the director of the Afghan Meteorological Authority, who had spent much of the late 1990s on the down-low. The Taliban

consider weather forecasting to be a form of sorcery or witchcraft. In Baghdad in April 2003, right after the Iraqi government fell, I went in with three other SOWT and set up the first unattended weather sensor.

PM: What attracted you to this kind of work?

JB: I was drawn by a love for the weather and oceanography. And the adventure.

— KATIE MACDONALD

THE

FUTURE

1

2

3

4





A BALLOON TO THE EDGE OF SPACE

Even in this time of private rocket ships, space travel for most of us still seems a speculative, far-off dream. But World View Enterprises can get you there, at least to the edge of space, next year. Its helium-balloon ride rises so high—to 100,000 feet, about three times farther up than commercial airliners fly—that you travel inside a climate-controlled capsule. As you lift off in Page, Arizona, cocktail in hand (there's a bar), you'll watch as the Grand Canyon yawns open. The park gradually shrinks away until you can see all of Arizona, then the entire American West. Then, finally, the curvature of Earth itself is revealed, and the planet floats below in its blue-green grandeur. The capsule includes Wi-Fi, so Instagram away: At the balloon's sub-orbital apogee, passengers will take in views previously seen by fewer than 550 people.

The trip lasts about six hours, two of those at maximum altitude. To descend, the pilot vents helium from the balloon, then releases it, shifting flight duties to an open parafoil. The capsule floats down from there, landing up to 300 miles from the launch site. They'll fly you back there in a small plane—all for \$75,000. World View reaches and descends from these otherworldly heights using surprisingly retro technology: a polyethylene balloon and the kind of parafoil a skydiver would use, only much larger. The views, however, are all straight from the future. — CAMERON JOHNSON

OF

2 > THE PERSONAL AIRCRAFT

Welcome to the era of the personal flying machine. The Icon A5 is a lustrous carbon-fiber two-person plane that takes off from and lands on water or paved surfaces, and whose wings fold up so it can be towed. Cofounder Steen Strand says production for the A5, which is twenty-three feet long and has a thirty-four-foot wingspan, is starting this year. The \$189,000 craft has already tallied 1,250 preorders, and Icon plans to build 300 by the end of 2016.

Certification to fly the A5, which means getting a

sport-pilot license, takes about a week. A single stick, rudder pedals, and a throttle maneuver the plane. It has a twenty-gallon fuel tank and can run on premium auto fuel, with a range of about 350 miles. It's the aeronautical version of driving a golf cart. "Flying is a fairly easy thing to do," Strand says. "Taking off and landing take a lot of practice. But just flying through the open sky is easier than driving your car down the road."

You can land in San Francisco Bay or hop between lakes. Or commute to the office. There's not much traffic up there. — JOE BARGMANN

3 > THE ELECTRIC SURFBOARD

If you've ever surfed or swum along with a wave headed toward shore and caught it just right, you know the feeling that comes when the water lifts you and hurtles you forward at a speed, and with a giddy force, beyond anything you could marshal on your own. Now there's a toy to simulate that feeling anytime, in any significant body of water: an electric surfboard called the Lampuga. The board, named for the fish better known as the mahimahi, one of the fastest in the sea, can whip you across the water at speeds up to thirty-four miles per hour.

At eight-plus feet long, it looks like a slightly bulbous longboard. Inside the casing—a composite of carbon fiber and aluminum—sits a fifteen-horse electric jet-drive motor that sucks water from under the board and spits it out the back. The steering is controlled via a towrope. The handle has a thumb-operated throttle, so you can also sit or lie on the board and hold built-in handles. If you fall off, a magnet in the safety leash cuts power to the engine. On the \$17,500 Lampuga, the waves never stop rolling—until it's time to plug in again. — C. J.

ADVENTURE

CONQUER THE OCEANS! EXPLORE THE HEAVENS! SOON!



THE DIVING SUIT

You are hundreds of feet below the ocean's surface. The water's weight is enormous, yet you move easily in your aluminum-alloy suit. See something shiny on the ocean floor? Activate the thrusters on your back—two vertical, two horizontal—to glide to that

spot. Your hand-like attachments are dexterous enough to snatch a quarter off the bottom of a pool. Ready to head up? Fire the thrusters again. And don't worry about the bends—the suit maintains a constant air pressure.

The gear that makes this adventure possible is called

the Exosuit. Its creator, Phil Nuytten, founded a company focused on designing equipment to operate 1,000 feet underwater, where the suit's smallest rotary joint is subject to 12,581 pounds of pressure. "It's like taking a pickup truck, dropping it down on a six-inch-diameter bearing, and

expecting to be able to rotate it with your fingers," he says.

The first custom-built models shipped in 2014, and Nuytten put a production line in place this year. Customers include explorer Jean-Michel Cousteau. For the rest of us, a new world is about to float within reach. — KEVIN DUPZYK

THE UNITED STATES OF

At two miles, the Mount St. Helens Ape Cave Lava Tube makes you feel 8 years old again.

Take a two-day knife-making course using a forge and an anvil at Trackers Earth.

West Glacier
Help researchers count and observe mountain goats in Glacier National Park's steep backcountry.

Reno
The BaseCamp Outdoor Wall is 164 feet up, the nation's highest climbing wall. Look down at your own risk.

After a how-to clinic, help wrangle the Double Rafter ranch's herd to summer grass.

Regent
See seven giant sculptures on the thirty-two-mile Enchanted Highway, including a forty-foot-tall pheasant.

Mosca
Zip down 750-foot hills at Great Sand Dunes National Park on a sled (from the Oasis Store) built for the desert.

Oklahoma City
Hit the road for up to twelve hours a day chasing tornadoes with experts from Storm Chasing Adventure Tours.

Ride a cart
2,300 feet below
ground for a
tour of Soudan
Underground Mine
State Park.

Decorah
NEI Fly Fishing guides will take you to their favorite streams in the gorgeous Driftless Area.

The Track Family Fun Parks boast a pair of four-story, 1,000-plus-foot-long go-kart tracks.

The Paiute ATV Trail runs for more than 2,000 miles through canyons and past elk herds.

Paintball at Camp Pendleton, a Marine Corps base: Take cover behind helicopters and tanks. Fire at will.

Hop in a Jeep at the Enchanted Circle Gateway Museum and pan for gold at 10,400 feet.

San Antonio
Batman: The Ride is a Six Flags roller coaster with unique rider-inversion technology.

Murfreesboro
Crater of Diamonds
State Park is the
only place the
public can dig for
diamonds—and keep
what they find.

Honolulu
At Island Watersports Hawaii, get a scuba-like experience on a self-propelled submarine scooter.

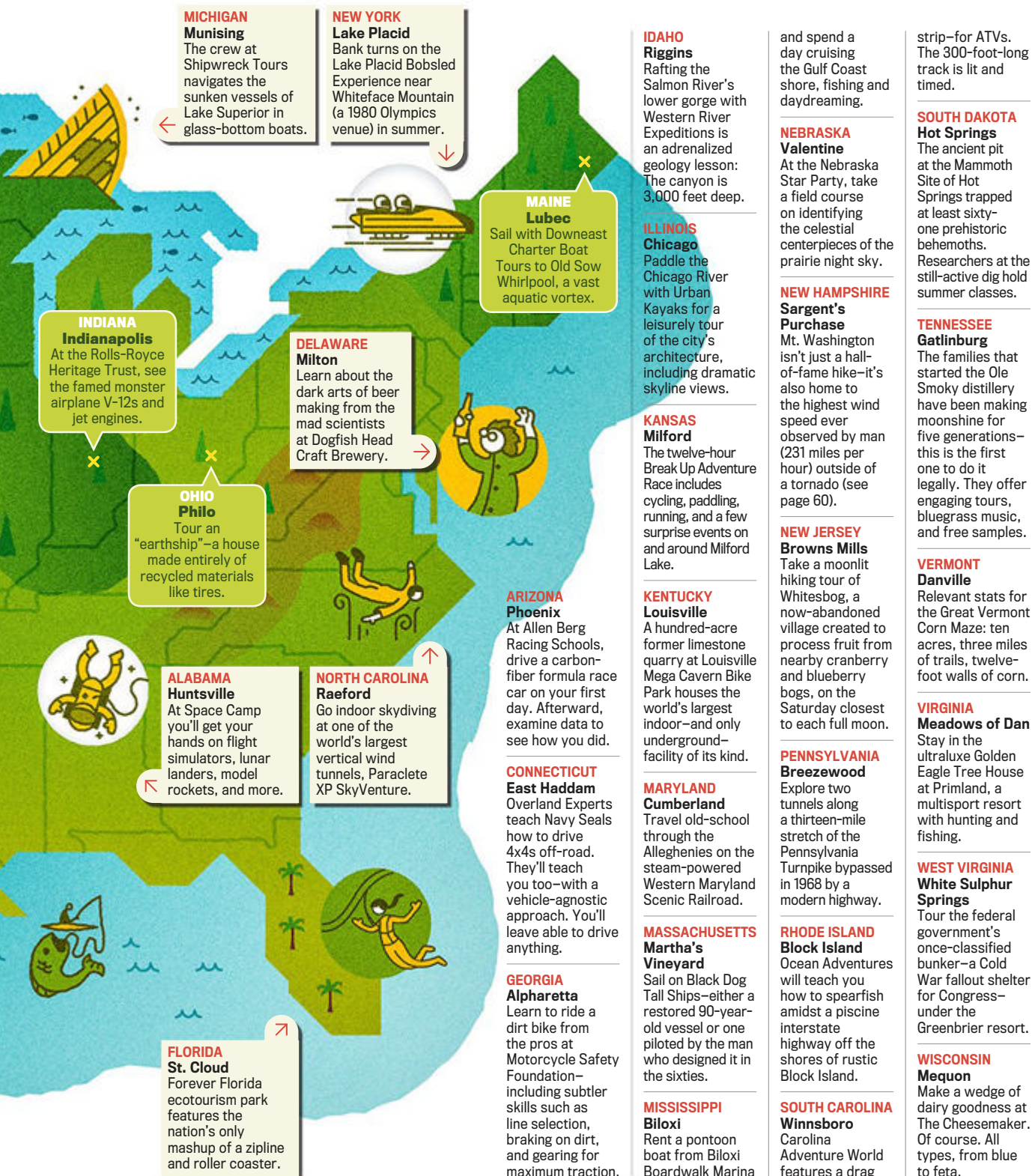
Take a floatplane with Bald Mountain Air Service to see grizzlies in their natural habitat.

The folks from Kayak Venice will show you where to hook a fish that "will tow you faster than you can paddle."

ADVENTURE

We found heart-pounding fun in all fifty states. Gas up the car, pack up your gear, and make it a memorable summer—no matter where you live.

BY KEVIN DUPZYK





**BUCK KNIVES
106 COMPADRE RED
STEEL HATCHET**

Made of 5160 spring steel, the same strong, flexible metal used in car suspensions, the Compadre has Buck Knives' newest finish: a red powder coat that prevents rust and corrosion.

\$120



PHOTOGRAPHS BY
MASSIMO GAMMACURTA

GREAT

NEW

ADVENTURE
EDITION

STUFF

The things you need in your
life this month.

Now get outside and use them.

1 MOUNTAINSMITH COOLER TUBE

The most convenient way to carry a six-pack up the mountain. **\$25**

2 SPIEWAK FISHTAIL PARKA

Spiewak drew on its 100 years of experience making gear for firefighters and police to create a jacket with a reflective camouflage print that shines only when hit with direct light. **\$465**

3 OUTDOOR TECH BUCKSHOT PRO

A water-resistant flashlight and Bluetooth speaker that can power your smartphone. Along with a campfire, it's the perfect back-country companion. **\$80**



◀ THE ADVENTURE RULES ▶

Always have a plan.

Although not impossible, it's hard to call something an adventure when it begins with your mom dropping you off at the airport.

When traveling to a third-world country, use a backpack. It's harder for the self-appointed airport porters to "help" you with your bag.

And never eat the lettuce.



4
COLUMBIA
BLOOD AND GUTS
III CONVERTIBLE
PANT

These quick-drying, ripstop-nylon pants use Omni-Shield technology to repel blood, guts, and any other part of a fish you wouldn't want sticking to you. **\$65**

5
GO DESIGN
TRAVELCARD
CHARGER

A little thicker than a credit card, this charger can be stashed in your wallet for a few hours of power whenever you need it. **\$39**

6
SOG SWITCH-
PLIER 2.0
MULTITOOL

A pushbutton release gives you one-handed access to pliers, screwdrivers, a wire cutter, and six other tools without putting down your drink. **\$64**

7
RICOH NV-10A
ENHANCED
BINOCULARS

Image-stabilizing digital binoculars that use an algorithm to filter out rain, dust, fog, and heat waves. It'll even adjust the exposure so that you can see in near darkness, and an onboard GPS automatically logs your location when you save images. **\$3,875**

8
OLYMPUS
TG-860 CAMERA

Freeze-proof, impact-resistant, and waterproof to 50 feet, with a flip-up display for taking shots at odd angles, and a wide-angle lens to capture nearly everything. It can survive anything you can. **\$280**

It's in
 the nature
 of the
 human being to
 face challenges...
 We're required
 to do these
 things just as
 salmon swim
 upstream.

- NEIL ARMSTRONG

1
**LA SPORTIVA
CORE HIGH GTX
HIKING BOOTS**

To keep water out, most Gore-Tex boots also keep moisture in, but these use a new technology that channels sweat and moisture out through a membrane along the sole. **\$200**

2
**AMERICAN
MOUNTAIN CO.
503H SWEATER**

This lightweight, 100 percent American sweater can be worn on its own or as an insulating layer under a jacket when the sun goes down. **\$159**

3
**BIG AGNES
RATTLESNAKE
MTNGLO TENT**

A versatile three-season tent that solves the problem of where to put your lantern by integrating LED lights into the overhead seam. **\$350**

4
**RUFFWEAR
APPROACH PACK**

An easy, humane, and comfortable (for the dog, not you) way to add a little storage to your favorite hiking companion. **\$80**

5
**MOUNTAIN
HARDWEAR
HYPERLAMINA
SPARK**

SLEEPING BAG
The seams are sealed together instead of sewn, so the insulation isn't pinched into uselessness in some areas, and you don't have to sleep in a bag with cold spots. At just over 1.5 pounds, it's the lightest synthetic option available. **\$220**



The farther one
gets into the
wilderness, the
greater is the
attraction of its
lonely freedom.

- THEODORE ROOSEVELT



◀ THE ADVENTURE RULES ▶

For the sake of anyone you might turn to talk to, always angle your headlamp a little lower than you think it should be.

Vehicles, in order of likelihood to get you involved in something interesting: airplane (commercial), car, train, airplane (cargo), raft, burro, tap tap, time machine, airplane (Russian).

No strip-mining the trail mix.

SPACEX'S REUSABLE ROCKETS

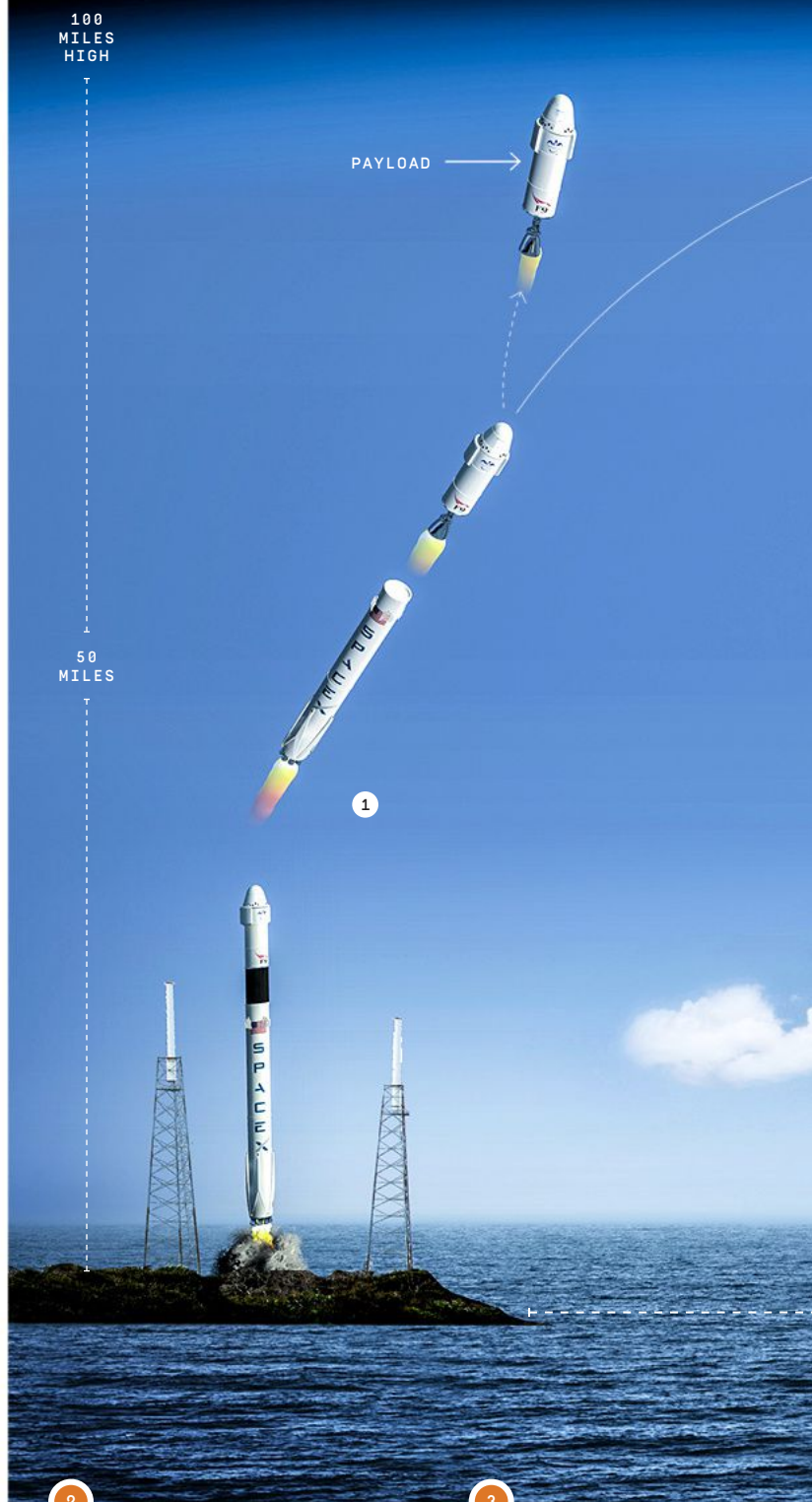
By Joe Pappalardo

Illustration by Sinelab

ON THE VIDEO it looks like a rocket launch played on rewind: A slender, fourteen-story aluminum-lithium-alloy tube, engines spouting fire, comes to Earth instead of roaring into space. Then, calamity. The footage from January shows the rocket veering at a too-sharp 45-degree angle, then exploding. That was the fiery end to the initial attempt by Space Exploration Technologies (SpaceX) to land the first stage of a Falcon 9 rocket for reuse on an unmanned ship floating in the Atlantic off Florida's coast. The day was technically not a failure. The second stage of the Falcon 9 delivered its payload to the International Space Station on behalf of NASA. But everyone was far more interested in what happened afterward, with the "autonomous spaceport drone ship" landing, because of what it could mean for the space industry.

Today's launch systems drop spent stages into the sea, but SpaceX and other private space companies want to fly them down to Earth—or a barge on the ocean—and reuse them. SpaceX officials say this could drive launch costs from about \$60 million down to \$7 million, and thus change the way the world industrializes—and possibly colonizes—space. "That will lead to space travel being just as easy and inexpensive as traveling from New York to London is today," says James Pura, director of the Space Frontier Foundation.

SpaceX determined that the crash was caused by an inadequate supply of hydraulic fluid during the flight's last few minutes. The fluid powers fins that help steer and stabilize the rocket. Engineers set to work preparing to try again, possibly at a newly rented location at Cape Canaveral. Here's how the process will work.



1 LAUNCH AND STAGE SEPARATION

A two-stage Falcon 9 rocket rises from its launchpad, and at an altitude of fifty miles the first-stage booster separates. The payload continues into space, riding on the second stage. The first stage coasts to about a hundred miles in altitude, then begins to descend.

2 BOOST-BACK BURN

Three of nine engines from the first stage reignite. The rocket has its own guidance-control system, which gimbals (orients) the Merlin 1D engines to rotate the rocket between 120 and 180 degrees. This aims the rocket toward the drone ship. The booster is traveling at nearly 3,000 miles per hour.

3 SUPERSONIC RETRO-PROPULSION BURN

The center engine ignites to slow the descent and gimbals itself to help the booster become fully vertical. Four grid fins extend to stabilize and further brake the cylinder. Each moves independently to control roll, pitch, and yaw. The rocket's speed drops from 3,000 miles per hour to about 560.



HYPERSONIC
FINS

LANDING
LEGS

200
MILES
[JANUARY
2015
ATTEMPT]

LANDING BURN

The engines initiate a final burn to slow the craft to about five miles per hour. Four carbon-fiber-and-aluminum-honeycomb landing legs unfold, powered by compressed helium.

TOUCHDOWN AND RECOVERY

The booster lands on the floating pad. Technicians on a vessel positioned miles away head over to board the drone ship and secure the rocket to the deck with metal shoes and vent any leftover gases. The drone ship ferries the first stage to shore, where it can be processed, cleaned, and reused. Flight length: about nine minutes.

FLOATING LANDING PAD

The drone ship is equipped with a dynamic positioning system that uses azimuth-thruster engines to keep it at a specific GPS point hundreds of miles (in the case of the January test, about 200 miles) away from the launchpad, give or take ten feet.



LEARNING TO FLY

PART

1 OF 4

TAKEOFF

In the first of a four-part story about learning to fly, an acclaimed novelist takes the controls of an aircraft for the first time. And he's scared to death.

BY JOSHUA FERRIS

PHOTOGRAPHS BY DANIEL SHEA



I WAS TERRIFIED. I DON'T MEAN OCCASIONALLY.

I mean that terror, as an emotion, as a prevailing mood, had overtaken my life. I woke in the night gulping for air, my heart going faster than ever. Why? Another bad dream. It was 3:13 a.m. There was no getting back to sleep. In that dark and terrible hour, I thought dire things.

From where did the terror spring? How could I put it back in the bottle? I didn't know. I couldn't trace it back to any one thing. I was about to turn 40. Was that it? In the end, I assumed it was death. Death, for me, is bound up in everything: my fear, my ambition. Humor, sex, the urge to travel. Death is why I shouldn't drink. Death is why I do.

Last summer, I watched my dad die. That might have been the source of it. I saw him laid out upon a hospice bed in the library of his house in Park Ridge, Illinois. It left me feeling more vulnerable than usual. Or perhaps—and this was the most terrifying thought of all—the terror sprang from nothing and was here to stay.

That summer was a good one for terror. ISIS. Ebola. The kidnappings by Boko Haram. Russians invading Ukraine. Israelis and Palestinians at war again. The police shooting in Ferguson and the mess that followed. Warnings of drastic climate change and continued odd weather. I saw birds flying what seemed like meaningful patterns and I thought nothing was immune from the taint of terror.

So what did I do? I decided to learn how to fly.

TO GO UP IN THE AIR inside a machine is a very stupid thing to do. It is also transcendently cool and extremely practical. We go up for sport. We go up for commerce. We go up for war. We go up so effortlessly and routinely these days that it's easy to forget what it entails: the elevation of a mighty payload of metal and fuel, with souls aboard, by the incorporeal air. Physics says it's possible over and over again on the departures board at JFK, but common sense stubbornly insists that it's just plain dumb.

The variable in every flight is the pilot. The laws of physics might be absolute, but with human beings there are no guarantees. Physics doesn't care what the pilot does, because whether the pilot lives or dies, its rules will be respected. Physics is like the indifferent farmer in Bruegel's *Landscape with the Fall of Icarus*: as the prideful pilot-child plunges into the sea, physics plows on with its day's work.

Today, flying is nothing. We've been doing it for over a hundred years. The golden age of aviation gave way to the golden age of air travel, which has soured into a protracted era of airline-induced misery. The contemporary commercial flight is a shrug and a hassle. The

seats have shrunk, the crew hates the passengers and the passengers hate each other, and for everything there is a fee. Romance has quit the skies.

But do it yourself—pilot a plane from takeoff to landing, in command of every climb and dive—and see if your pulse doesn't quicken and the raw color come back to your eyes.

The question is no longer, Can we fly? The question to ask yourself is, Can *I* fly?

I TOOK FLYING LESSONS for four months from Tom Fischer, who, with his wife, Jodi, runs Fischer Aviation in Fairfield Township, New Jersey. Seeing Tom for the first time, my initial thought was that a man could not have been better engineered for flight instruction. A pale man of substantial build, with eyeglasses and a shaved head, he split the difference perfectly between an Army general and a sixth-grade math teacher. If he seemed reserved at first, laconic in the style of a military man, and if I generally liked my teachers verbal and outgoing, that was okay. His first task was to keep me alive, and I didn't mind if the job description called for the occasional silence.

My ultimate objective was to fly solo. I was never confident that I would actually do something so reckless and brave. I mean to say I didn't think it possible, either physically or psychologically. I'm not a mechanically inclined man, but I am a man scared to death of flying. Sweaty palms, rapid heartbeat, darting eyes, hands gripping armrests, tears on standby, a scream ever perched on the edge of my teeth. And that's before takeoff. For me, there is terror, and then there is the terror of flight.

I was not always so afraid. In the eighties, after my parents split and my mom moved us away, I'd board a plane several times a year for Chicago. These trips



LEARNING

TO FLY

1 OF 4

Joshua Ferris is the author of three novels, including *Then We Came to the End*, a finalist for the National Book Award, and *To Rise Again at a Decent Hour*, nominated for the prestigious Man Booker Prize in the first year American writers were eligible to receive it. Look for the second installment of "Learning to Fly" in our next issue.

north were my reason to live. They reunited me with my dad. I loved airplanes back then, even the weird engine sounds and Reagan-era turbulence. The stewardesses gave me a pair of golden wings to pin to my shirt, and when I was really lucky, a free can of Sprite all to myself. At that time, anyone could go to the gate without a ticket, so I'd come down the gangway to find my dad standing there with a big smile on his face, tears in his eyes, arms spread wide, and I'd run into that man's embrace and breathe in his aftershave and I'd know that I was home.

Much later, in 2003, I boarded a flight out of John Wayne Airport in Orange County, California. I was by then a nervous flier, which I differentiate from the wreck, the puddle, and the basket case. I was, in other words, acquiescent but attentive. I listened for changes in engine noise, alive to every ripple and quiver of rough air. Some flights departing John Wayne are required to climb very high very quickly and then cut back the engines to reduce noise as they glide over the wealthy neighborhoods down below. For a full minute, it felt to me like I was inside a rocket. When we leveled off, the first thing I noticed was the sunlight. As it streamed in through the windows across the aisle, I seemed to be able to pick out each individual ray. That was the cabin beginning to fill with smoke.

Two things happened next. The first was the sounding of a high-pitched, continuous, not-too-loud bell—the smoke alarm. The second was a faint odor, indisputable and growing stronger: an industrial smell, like someone using turpentine to burn a plastic toy. By the time my fellow passengers stirred from their naps and magazines, we were in the thick of an emergency. Panic set in quickly. There were screams, tears. The woman in front of me began to hyperventilate. The plane turned back, but because we had climbed like a rocket, we now had to come down like one. The descent did not seem planned or orderly. It felt like we were crashing. The captain offered us no reassurances, only a single, harsh instruction: “Breathe through your shirts.” I watched in dismay as the stewardess, stricken and useless, put on her chest harness. The woman next to me kept asking between sobs if we were still over water. We were. I put my arm around her. I was strangely calm. A mother held hands across the aisle with her son. We all waited for impact.

But impact never came. We touched down shakily but intact. We were met by emergency vehicles. We filed off the plane. Two free vouchers arrived in the mail a few months later, along with an explanation. The motor responsible for pressurizing the air had burned out and released smoke into the cabin. The plane itself was fine.

But part of me feels like I've been living on borrowed time ever since.

“What's the worst that can happen to me?” I asked Tom before we took our first flight together.

“On a training flight?”

I nodded. Tom and I were very different men, if based only on our choice of professions. I'm a writer who never enjoys lifting my butt off the office chair.



Ideally I don't leave the house, and a perfect day is one in which I don't get out of bed. Tom, on the other hand, departs *the earth* multiple times a day.

“People unfortunately die in flight training,” he said after a long pause. “I would think that would be the worst thing.”

Ha ha. Yes.

“I tell people all the time,” he added, “it's a lot of fun, but it's not a game.”

With that, we headed out to the airfield.

The last time someone taught me to do something big with a machine, I was learning how to drive. By then I had moved north to live with my dad. He had been teaching me to drive for years. I was 7 when he first put me on his lap and let me steer the car around the parking lot. Now I was old enough to do it on my own. At night, on sleepy suburban streets, he and I went out and worked on things like signaling and turning and braking on time. I was a trepidatious student. The simulation videos in driver's ed instill in the sensitive young man the conviction that at any given instant he is about to strike and kill a child on a tricycle. I didn't want to kill anyone, so my general approach behind the wheel was to look, accelerate, brake, look, accelerate, brake, until, inch by inch, we made our way down the street. This tried my father's patience. He was a man who liked speed.

During my time in the air with Tom I would be reminded of all the time I spent in the car with my dad. My reluctance to assert myself on the stick and rudder was not unlike my reluctance to go above fifteen miles per hour while white-knuckling the steering wheel. At a certain point in my driver's education, when I knew

how to accelerate and brake and all the rest, and the only thing that stood between me and authority was fear, useless fear, my father said to me, “Just drive the damn car!” This command came back to me from the beyond at some point during my flying lessons. Twenty-five years later I was still listening to my old man. Now I sometimes think that the story of how I learned to fly is really just the story of how I learned to stop worrying and fly the damn plane.

I WOULD LIKE TO INTRODUCE YOU to my airplane. We call it Six-Two Romeo, after the call sign painted on its fuselage. It is a single-prop Piper Cherokee Cruiser. It has four seats and wings perched below the pilot rather than above. It has a wingspan of thirty feet and weighs 1,250 pounds fresh from the bath. It’s a snug ride. Tom and I sit thigh to thigh. The student is on the left, the instructor on the right. The plane is engineered with dual controls. Its underbelly is painted brown, with twin ribbons of gold flowing along the fuselage. There was, I thought, something dated about its design. I asked Tom what year the plane was made.

“1966,” he said.

That was the first time I wanted to run away. (I would want to run away with stunning regularity, often while 2,500 feet up in the air.) On the one hand, a plane built in 1966 has demonstrated an extraordinary safety record. On the other hand, sooner or later, everyone’s luck runs out, and that Cherokee had almost fifty years under its belt. How much more could we reasonably expect from it?

“Isn’t that kind of old?” I asked him.

He paused before answering. “I was born in 1967,” he said.

We began to laugh. Ha ha ha.

My problem was a lack of faith. In order to better understand people who deny scientific knowl-

edge that I find easy to accept, like evolution or the man-made causes of climate change, I merely need to remember my skepticism toward the indisputable physics of flight. I had a hard time believing that flying was possible, no matter how often I’d gone up and come safely back down. I didn’t just think Tom’s 1966 Cherokee alone would fail to hold together. I thought *every* plane I boarded would fail to hold together. A thing of such size, subject to such wear and tear, was bound to break apart, inevitably with me in it.

A year or so after my emergency landing at John Wayne Airport, when my fear of flying was at its most rabid, I tried to get a handle on it. It was summer, and I had an oscillating fan going in the bedroom. During the hot months that fan went round and round all day and all night. I looked at it, at its spinning blades and rotating head, and wondered why I never had the same worries about it that I had for all the planes I boarded. The stakes weren’t the same, of course, but was an

airplane not a machine like the fan? The fan worked unfailingly, without a single hour of maintenance, and had for years and years, and I never once questioned my perfect faith that it would continue to do so for years into the future. Why should I not have the same faith in an airplane? If anything, an airplane is subject to more scrutiny than a household fan, its use is heavily regulated by the FAA, and entire maintenance crews are devoted to keeping it safe and operational. After this little epiphany, whenever I boarded a plane, I took enormous comfort in my simple fan and its continuous and faithful turning.

Then the fan broke.

THE AIRPORT OUT OF WHICH Fischer Aviation operates is called, informally, Caldwell Airport. It’s off Passaic Avenue, hidden behind some chain-link fencing. Blink and you’ll miss it. Compared to Newark or JFK, it’s a parking lot full of toy planes and a patch or two of tarmac. (I was surprised to discover during my time in the air just how many little airports there are, at least in that corner of New Jersey, several of which are uncontrolled. Accustomed as I was to the strangulating regulations of commercial flight, I found amateur aviation still very much a scrappy, DIY thing, just some guys taking their winged go-karts up for a spin.)

Out by the plane, the first thing Tom and I did was go through the preflight checklist. Never am I more skeptical about the ultimate wisdom of our experts in aviation than when I see some short-sleeved pilot suffering the indignities of wind and rain to stand beneath the belly of a plane and eyeball the structural integrity of a row of rivets. That’s it? I think. *That’s* safety? But it was no different with Six-Two Romeo. Tom and I crouched and contorted, we loomed and looked as we inspected the plane’s bolts, pins, winches, and wingtip lights. We felt down the length of the propeller for any imperfections. We stopped before the cowling (what I wanted to call the hood), and Tom popped it open like the lid on a lunch box to reveal an engine that could have been started with a few yanks on a pull string. We checked it for fire damage and the presence of animals. In everyday life, I have grown accustomed to a computer or some other device mediating between me and the world. The digital magically renders error and danger obsolete. But search an engine for animals and you know you’re back to the basics. It’s just you and your eyeballs and whatever faith they can lend that the engine hasn’t been molested by some rabbits.

As things progressed, I continued to see just what a thoroughly analog experience flying can be. In Six-Two Romeo there is no autopilot, no computer, no digital communication between the pilot and the controls. A commercial Airbus or Boeing jet might be one intricate and high-powered mainframe, but Tom’s Piper Cherokee was a distant cousin of the lawn mower. Expand the motor on your rider and take away a wheel, enclose the seat and add one for a buddy, throw on a pair of wings, and presto. Your grass eater is now ready for takeoff.

It was kind of thrilling. Here was a well-engineered (if a tad aged) block of metal and wire nestled inside an aerodynamic hull. It was going to put me up there in

THE WORLD WAS SUDDENLY UNRECOGNIZABLE AND MORE DANGEROUS THAN BEFORE. MORE VULNERABLE.



LEARNING

TO FLY

1 OF 4

the blue sky as if by magic. And I would guide it there using nothing but my hands and an intimate physical knowledge of how it worked. No updates, no inputs, no hitting enter. Just me and the 1.0 world.

Once through with the inspection, we climbed into the cockpit. We put on seat belts escaped from the back seat of an Oldsmobile. The analog nature of the Piper Cherokee continued to reveal itself. The yoke, which controls both the pitch and the bank of an airplane, moved in and out and left to right with the matter-of-fact functionality of a primitive arcade game. The rudder pedals at my feet were notched, metallic, and brutal. There was a trim tab control (I did not know what any of this meant practically) affixed to the ceiling that resembled the hand crank of a window in a municipal building, while the wing flaps were controlled by what looked like an emergency brake lever. I would come to learn that at certain critical moments, such as landing, the pilot, manipulating all of these controls at once, can look not unlike one of those multi-instrumentalists simultaneously strumming the guitar, blowing the harmonica, and tapping a foot drum.

I started the propeller with the push of a button. I struggled to insert my two headphone jacks into the instrument panel—a poor harbinger of my competency with the more complicated controls before me. Then Tom radioed to air traffic control and we taxied to the runway.

As I sat before the yellow lines waiting for take-off that first time, my heart banging for its jailers inside my chest, I had second thoughts. Even now I wonder: Would I have started down the path toward a solo flight—what I had begun to call my date with the NTSB—if I had known then what was coming? I'm thinking of the time, six lessons in the future, when I pointed the plane at the runway nose down as we were landing and didn't know it until Tom took the controls. Or the time I failed to recover from a stall because I forgot how, and instead of pulling back on the yoke to initiate a positive climb, I just let us fall, with stomachs bottoming out as we stared down at the tops of trees, until Tom took the controls. Or the time I just let go of the yoke at a critical moment and Tom said, "Don't let go!" Or the time I should have gone around during a touch-and-go but decided to try to land anyway, going too high and too fast, and we wobbled violently very close to the ground until Tom took the controls. Or during yet another landing, when I came into ground effect and suddenly yanked up on the yoke so hard that we started to climb again, but having such little speed we were close to stalling out, and Tom called for more power to get us out of that mess, but, for reasons that still elude me, I simply didn't react, and we might have dropped to our deaths if he hadn't, once more, taken the controls.

I didn't know any of that before taking off with Tom for the first time down runway 22 in Six-Two Romeo. I couldn't have anticipated the number of times he'd save my hide from ruin, or how frightening it was to play back the day's mistakes, or how the airplane would start to invade my dreams. I sensed only my fear,

as well as a vague necessity.

My father couldn't breathe toward the end of his life. Pancreatic cancer, which he'd somehow gotten the better of for seven long years, had finally overtaken his lungs. In the days and weeks after his death, I, too, couldn't breathe. I felt, in life, little distinction between my dad and me. We extended our imaginations to one another. That's what love is. It was impossible for me to stop doing so just because he was dying. If he could



ail, I could ail. If he could die, I could die, too. The world was suddenly unrecognizable and more dangerous than before. More vulnerable. More terrifying.

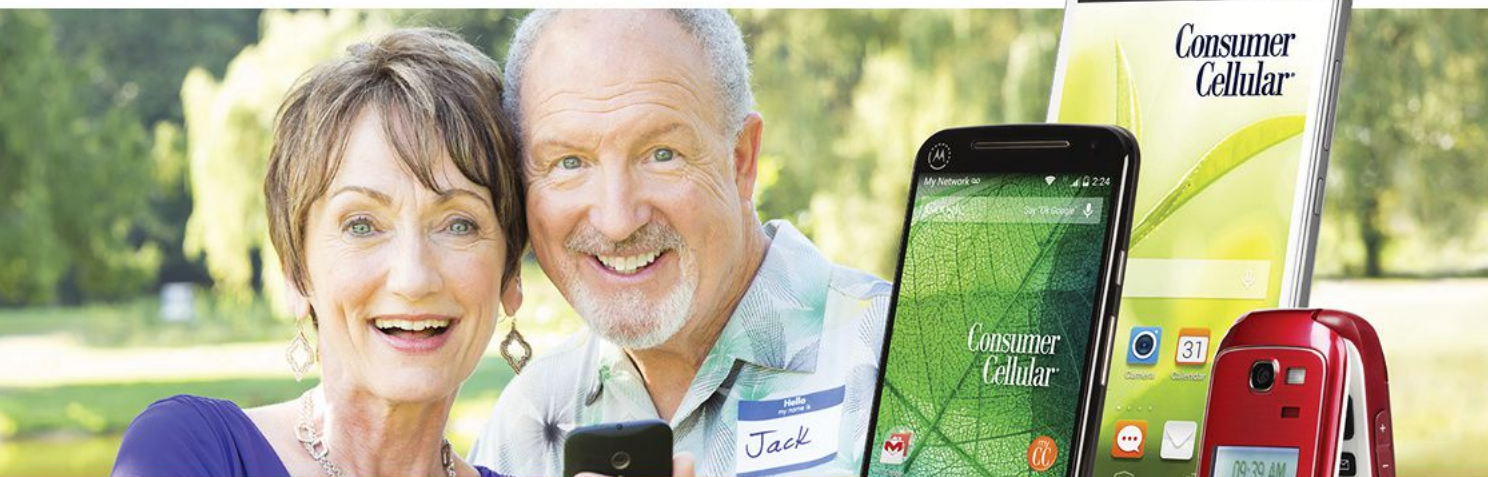
It took months after my dad passed away for me to understand that I wasn't going to follow him immediately to the grave. It was his turn, unfortunately, not mine. I wasn't even 40 years old yet. No matter how wrecked I felt as I watched him die, I wasn't going to just give out. Neither was that old Piper Cherokee, not with the love and attention Tom paid it. I had to have a little faith. I was scared, but I had to live. For me, and for my old man. And what's the best way to live in the face of death?

Fully is always the best way to live.

Just fly the damn plane.

So when Tom gave the command to engage the throttle on Six-Two Romeo, I engaged the throttle, and we turned, and took the center line, and off we went, down the runway and into the air.

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PROJECT



This is made out of cardboard, tape, and circuit boards we bought online.

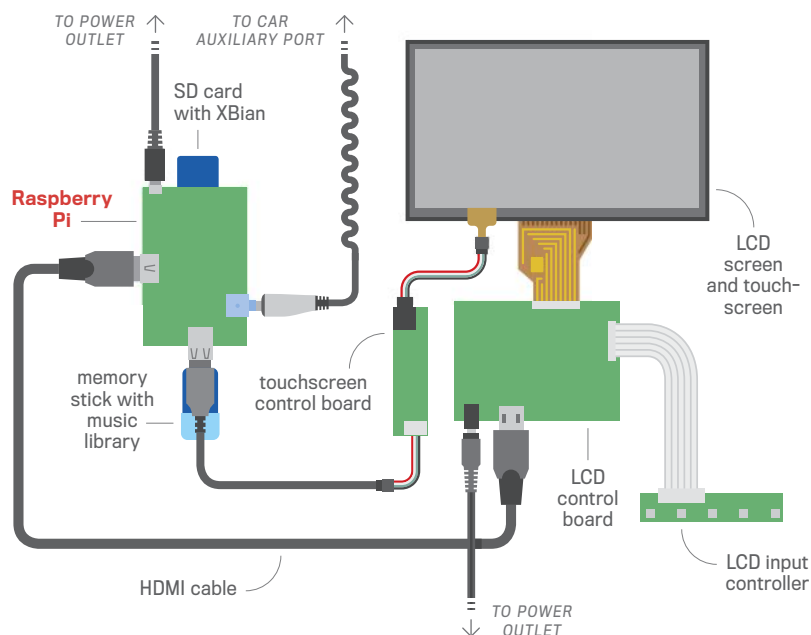
The DIY Dashboard

Update your ancient auto with a touchscreen music system you built yourself. **BY ERIC KESTER**

HAVE YOU EVER BEEN STUCK IN traffic and pulled up next to some maniac singing along with the radio to an audience of no one, index fingers drumming out a spastic beat on the steering wheel? That's me. As a married man living in Manhattan, I have a special affinity for my car's cloistered interior. It's a rare womb of privacy, a work-and-email-free bubble where I can reflect quietly or rock out as the day requires. ➔

ASSEMBLING THE PI

The layout for your brand-new sound machine.



A few months ago I realized my haven was losing its appeal, and I sensed it was connected to my radio's anachronistic scan button. In a world filled with customized on-demand entertainment, the clunky AM/FM radio in my 2008 Ford Taurus is embarrassingly dated. I can pretend I'm Jay-Z all I want, but his ride has to feature a media center with more than six FM presets.

So I decided to see if I could build a touchscreen dash personalized with thousands of my favorite songs using a Raspberry Pi, a computer board barely larger than a credit card. If you haven't heard of Raspberry Pi yet, remember the name—this easy-to-use microcomputer is taking over the programming world. Lauded by amateurs for its accessibility and by experts for its versatility, the Pi has been the catalyst for all sorts of cool projects: voice-activated coffeepots, self-watering plants . . . even touchscreen car dashboards.

You can find a Raspberry Pi online for less than \$50, and I ordered mine from the tech website adafruit.com. Setting it up for this project was fairly straightforward. The Pi is basically a Swiss Army Knife of inputs that you're already familiar with: HDMI and Ethernet connects, four USB ports, an audio and analog video

port, and an SD card slot. This last input is the most important because the Pi runs its operating system (known, a tad confusingly, as its "image") from an SD card.

There's a bustling online community of Raspberry Pi coders who make preprogrammed images available for download. When I searched for images that would run a homemade media center, a site called xbian.org had the most popular version: software for a media hub akin to what you see on an Apple TV. It can play music and movies, display pictures, and run other media apps such as Pandora—it can even stream content from Apple devices using AirPlay. Most conveniently, XBian can be played on any screen with an HDMI input, including the touchscreen I planned to build. I popped an 8-gigabyte SD card into my laptop, and by following the step-by-step directions of the free installer I downloaded from the XBian website, I copied the image directly onto my card. Then I ejected the card, slid it into my Raspberry Pi, and congratulated myself on becoming a genuine programmer.

Assembling the actual touchscreen—a Tontec seven-inch HD screen I found on Amazon for \$75—was a bit trickier. The touchscreen comes with a primary control board that looks strikingly similar to the Raspberry Pi, plus two smaller control boards, all of which help communicate data to the Pi. The LCD screen and the glass touchscreen, meanwhile, don't come attached to each other because I guess that would make too much sense, so I had to connect them myself. There's a rough guide online to making a touchscreen dashboard in which the author, a mysterious wise man identified only as Zaqq, explains how to do this with masking tape. I simply aligned the touchscreen atop the LCD screen, then ran tape along the centimeter-thick edges of the two stacked screens. For security I used five layers of tape, and I folded any excess neatly onto the back of the LCD screen.

To work properly, the touchscreen needs to be connected to its three control boards via three cables. Tontec does not include instructions, but each wire snaps exclusively into a specific corresponding jack, so I managed to connect everything using trial and error. Next I linked the touchscreen to my Raspberry Pi through HDMI and USB cables. I plugged the Pi into an outlet with its included power adapter. The touchscreen didn't come with one, so I plugged it into the wall with

MATERIALS

FOR THE RASPBERRY PI:

- Raspberry Pi Model B starter kit (includes 5-volt AC/DC power adapter)
- 8 GB SD memory card
- USB keyboard
- Ethernet cord
- USB memory stick loaded with personal music library

FOR THE TOUCHSCREEN:

- Tontec 7-in. touchscreen (comes with control boards and wires)
- Tontec 12-volt power adapter
- Masking tape
- HDMI cable

FOR THE INSTALLATION:

- Screwdriver
- Duct tape
- Foam board
- Standard auxiliary cable
- Radio harness extender
- External battery (5,000 mAh or higher) with multiple USB ports
- Micro USB cord
- USB-to-barrel plug (size 5.5 x 2.1-mm) cord

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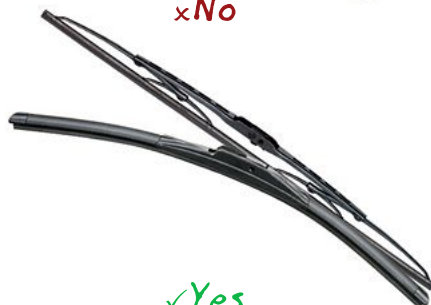
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PROJECT

a twelve-volt AC/DC adapter I bought separately.

Both the Raspberry Pi and touchscreen turned on automatically. Then I had to get the XBian operating system synced with the touchscreen, and that required installing some drivers directly to the Raspberry Pi from the Internet. To do this I plugged the Pi into my modem with an Ethernet cable, and, using the arrow buttons of a computer keyboard to control XBian (I connected the keyboard via USB), I highlighted the power icon in the menu screen and selected Exit. This closed the software and opened up the command terminal for the Pi.

Here is where things turn into a computer-hacking scene from a mid-nineties movie. The command terminal asked for a username and password. I entered "xbian" and "raspberrypi," respectively, then typed in a few gibberish-looking prompts recommended by Master Zaqq from that online guide. I'll spell them out here in case you're following along, but I strongly recommend supplementing these steps with your own Internet research.

In the terminal I entered *wget https://github.com/brantje/xbian-touch/raw/master/install.sh*, which downloaded the touchscreen driver, followed by *sudo sh install.sh*, which installed it to the Pi. After I complied with some onscreen prompts to orient the touchscreen, I was good to go. The calibration of the touchscreen wasn't as precise as I would've liked, but some tinkering would probably fix that. In the meantime I now had a slick media center that could play my entire MP3 library, which I had stored on

a 32-gigabyte flash drive that was plugged into the Pi's second USB slot.

At last: the hard part. I suppose I should have assumed that installing the touchscreen in a real car wouldn't be as easy as programming the Pi. Without some practice I was hesitant to disassemble my personal chariot, so I reached out to Brooklyn Automotive High School to see if they'd let me potentially ruin one of their practice cars. Always happy to assist a mechanical neophyte, the school, and in particular, a Mr. Renato Rosales of the school's electronics class, let me mess around with a 2009 Pontiac G6 they'd been taking apart and putting back together for years.

My first step was to remove the car's built-in radio, which was easy enough: With the help of Rosales, I popped off the plastic dashboard panel, unscrewed the radio, and yanked it out. Next I had to hook up my new media center to the car's sound system. This step varies from car to car, but in general you'll need to connect the car's speakers to the 3.5-millimeter



The author, seconds before connecting the touchscreen to the Raspberry Pi.

THE TOUCHSCREEN ROAD-TRIP PLAYLIST

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"I've Been Everywhere"

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Stone Temple Pilots

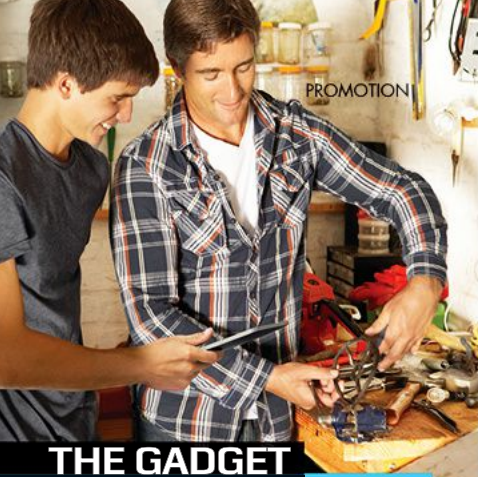
"Interstate Love Song"

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Edward Sharpe and the Magnetic Zeros

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PROJECT

audio jack in the Raspberry Pi. The simplest solution is to use a standard auxiliary cable to link the Pi to the car's auxiliary input, but this involves keeping the original radio connected (since it will be functioning as an amp). You can stash the radio in your glove compartment or under a seat, though the latter will likely require you to extend the radio harness (the collection of wires that work the radio). For this step Rosales suggests you "get a stock harness adapter that will plug into the vehicle's existing wiring harness and splice into the audio outputs from there." You can find harness adapters at most electronics stores. If your car doesn't have an auxiliary input, the easiest fix is to move the radio as described above, then use a cassette-player auxiliary adapter. It's very last decade, but it should work.

Both the Raspberry Pi and the touchscreen need their own power sources. For this I'd recommend getting an external battery that's 5,000 milliampere-hours or higher, with multiple USB ports. Raspberry Pi users seem to like Anker external batteries. Connect the battery to the Pi with a micro USB cord. Connect the touchscreen with a USB-to-barrel plug.

Once everything was connected and powered up, I took the Raspberry Pi, the control boards, and the wires and performed a fancy mechanical maneuver known by us programmers as "stuffing all of it into the empty radio cavity." Finally I duct-taped the back of the touchscreen to a black foam board and secured that to the inside of the plastic dashboard panel.

When I snapped the panel back into place, the touchscreen sat flush with the dashboard and looked naturally integrated. The Pontiac had become 100 percent cooler. After class some of Mr. Rosales's students even admitted that the dashboard looked "pretty swag."

It wasn't until they scattered that I actually fired up the system, threw on some Jay-Z (okay, fine, it was Adele), and basked in the elation of DIY success. Was it easy? Not exactly. Is it possible? Yes, and I'm here singing to prove it.

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HEAVY DUTY RETRACTABLE AIR HOSE REEL WITH 3/8" x 25 FT. HOSE

LOT 69266/69234 shown

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SUPER COUPON

17 FT. TYPE 1A MULTI-TASK LADDER

LOT 62514
67646 shown

• 300 lb. Capacity
• 23 Configurations

SAVE OVER \$81

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SUPER COUPON

80 PIECE ROTARY TOOL KIT

LOT 68986/69451
97626 shown

SAVE 68%

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SUPER COUPON

2500 LB. ELECTRIC WINCH WITH WIRELESS REMOTE CONTROL

LOT 68146
61258/61297
61840

NEW

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26540178

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26544701

WOW SUPER COUPON

900 PEAK/700 RUNNING WATTS 2 HP (63 CC) 2 CYCLE GAS RECREATIONAL GENERATOR

LOT 69381 shown
60338/62472/66619

NEW

SAVE \$80

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SUPER COUPON

10 TON HYDRAULIC LOG SPLITTER

LOT 62291
67090 shown

SAVE \$55

\$94.99

REG. PRICE \$149.99

26565515

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SUPER COUPON

16" x 30" TWO SHELF STEEL SERVICE CART

US • GENERAL

• 220 lb. Capacity

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LOT 60390/5107 shown

26562148

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LOT 61609
67831 shown

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26546600

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1/4" DRIVE
LOT 2696/61277
3/8" DRIVE
LOT 807/61276
1/2" DRIVE
LOT 62431
239 shown

SAVE 66%

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SUPER COUPON

3 PIECE DECORATIVE SOLAR LED LIGHTS

LOT 95588
60561/69462 shown

SAVE 66%

\$9.99

REG. PRICE \$29.99

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SUPER COUPON

ADJUSTABLE SHADE AUTO-DARKENING WELDING HELMET

CHICAGO ELECTRIC WELDING

LOT 61611
46092 shown

SAVE 55%

\$35.99

REG. PRICE \$79.99

26545482

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SUPER COUPON

2.5 HP, 21 GALLON 125 PSI VERTICAL AIR COMPRESSOR CENTRAL PNEUMATIC

LOT 67847 shown
61454/61693

SAVE \$70

\$149.99

REG. PRICE \$219.99

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SUPER COUPON

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LOT 62170
90154 shown • DOT certified

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3 PIECE TITANIUM NITRIDE COATED HIGH SPEED STEEL STEP DRILLS

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69087/60379

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26582679

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LOT 69684 shown 61776/61969/61970

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26681186

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3-1/2" SUPER BRIGHT NINE LED ALUMINUM FLASHLIGHT

LOT 69052 shown 69111/62522/62573

\$6.99 VALUE

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26683044

WOW SUPER COUPON

PACIFIC HYDROSTAR 1650 PSI PRESSURE WASHER

SAVE \$50

LOT 69488

1.3 GPM

\$79.99 REG. PRICE \$129.99

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26598958

WOW SUPER COUPON

SAVE 50%

60 LED SOLAR SECURITY LIGHT

Bunker Hill Security

LOT 62534/60524 69643 shown

\$29.99 REG. PRICE \$59.99

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26634270

WOW SUPER COUPON

HARDY POWDER-FREE NITRILE GLOVES PACK OF 100

• 5 mil. thickness

MEDIUM LOT 68496 61363

LARGE LOT 68497 61360

X-LARGE LOT 61359 68498 shown

SAVE 45%

\$6.49 REG. PRICE \$11.99

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• Weighs 27 lbs.

SAVE \$60

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LOT 69252/60569/62160 62496/62516/68053 shown

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26682208

WOW SUPER COUPON

SUPER-WIDE TRI-FOLD ALUMINUM LOADING RAMP

LOT 69595/60334/90018 shown HaulMaster

• 1500 lb. Capacity

SAVE \$70

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26684702

WOW SUPER COUPON

4-1/2" ANGLE GRINDER drillmaster

LOT 95578 69645/60625 shown

SAVE 50%

\$9.99 REG. PRICE \$19.99

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26607798

WOW SUPER COUPON

PITTSBURGH 40 PIECE 1/4" AND 3/8" DRIVE SOCKET SET

• SAE and Metric

LOT 61328 47902 shown

SAVE 60%

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26631763

WOW SUPER COUPON

4 PIECE 1" x 15 FT. RATCHETING TIE DOWNS HaulMaster

LOT 90984 shown 60405 61524 62322

SAVE 60%

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26585535

WOW SUPER COUPON

TRIPLE BALL TRAILER HITCH HaulMaster

LOT 94141 shown 69874/61320 61913/61914

SAVE 66%

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26643394

WOW SUPER COUPON

3/8" x 14 FT. GRADE 43 TOWING CHAIN HaulMaster

• 5400 lb. Capacity

Not for overhead lifting.

LOT 60658 97711 shown

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26604366

WOW SUPER COUPON

8" 5 SPEED BENCH MOUNT DRILL PRESS GENERAL MACHINERY

LOT 62390/62520/60238 shown

SAVE \$50

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26648671

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26626971

WOW SUPER COUPON

MIG-FLUX WELDING CART CHICAGO ELECTRIC

LOT 90305/60790 61316/69340 shown

SAVE 41%

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26657409

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LOT 61280 95692 shown

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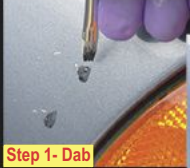


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New electronic lure may catch too many fish; one state bans it.

A bass every seven minutes.

by Mike Butler

NEWARK, DE— A new fishing technology that set a record for catching bass in Mexico is now showing its stuff in the U.S. It has out-fished shrimp bait in Washington State and beat top-selling U.S. lures three to one in Florida. The new technology is so effective one state, Wyoming, has banned its use.

The breakthrough is a tiny, battery-powered electrical system that flashes a blood-red light down a lure's tail when its moved in water. Fish think it's an injured prey and strike. Some fishing authorities, like those in Wyoming, think that gives fishermen too much of an advantage.

They may be right. Three fishermen using a flashing lure in Mexico caught 650 large-mouth bass in just 25 hours. That's a bass every seven minutes for each person, and a record for the lake they were fishing. They said the bass struck with such ferocity they hardly lost a strike.

In Florida two professionals fished for four hours from the same boat. One used a flashing-red lure; the other used some top-selling U.S. lures. The new, "bleeding"

lure caught three times as many fish.

Before reporting this, I asked a veteran fisherman in my office for his opinion. Monday morning he charged into my office yelling "I caught six monster fish in an hour with this thing! Where did you get it?"

Then I phoned an ichthyologist (fish expert).

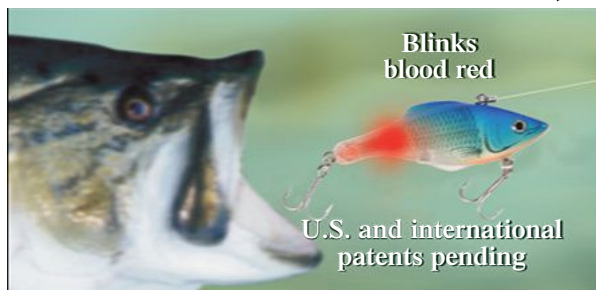
"Predators - lions, sharks," he said, "will always go for the most vulnerable prey. Fish are predators, so if a fish sees a smaller fish bleeding, it knows it's weakened and will strike."

"If a lure could appear to be a live, bleeding fish, a few fishermen could probably empty a lake with it."

I told him three almost did.

Fishes top, middle and deep

There is a U.S. company that offers a kit of three blinking lures (one each for shallow, middle and deep water) called the Bite Light®. Each lure is a different color. They work in fresh or salt water, contain rattle attractants inside and last 300 hours in the water.



New Bite Light® lure uses a blinking red light to create appearance of a live, bleeding prey. Triggers strikes.

This year, we're introducing a new series of the Bite Light, the Bite Light MM15, for even better action. One kit of three Bite Lights costs \$32.95, two cost \$29.95 each and three cost only \$25.00 each.

To order, go to www.FishingTechToday.com or call 1-800-873-4415 anytime or day and ask for the Bite Light® lure (Item #kbl). Or send your name, address and a check to Scientific Edge LLC (Dept. BL-191), 40 E. Main Street, Suite 1416, Newark, DE 19711.

The company gives you money back, if you don't catch more fish and return your purchase within 30-days.



STILTS

A project to build with your children.
DESIGNED BY ROY BERENDSOHN



Shopping List

QTY.	DESCRIPTION
3	2" x 3" x 8' studs
1	Box No. 10 x 3" Spax construction screws
8	¼" x 5" Spax hex-head lag screws
	80-grit sandpaper
	120-grit sandpaper

Materials Cut List

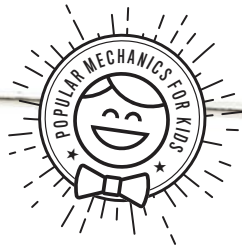
See diagram on the next page.

A	2	2" x 3" x 5' stilts
B	4	2" x 3" x 9" side supports
C	2	2" x 3" x 11" footrests
D	2	2" x 3" x 1' bottom supports

TOOLS Miter saw or circular saw, cordless drill, square, ⅝" x 6" drill bit, sander

Instructions

- 1. Crosscut two 2 x 3s to the dimensions shown in our cut list [A, B, C, D].
- 2. Determine how high up you want the bottom support block to be. (We recommend anywhere from 12 to 18 inches, depending on the height, enthusiasm, and agility of the kid.) Then mark a reference line across the main stilt [A] and secure the bottom support block [D] below the line with two 3-inch construction screws.
- 3. Center the footrest [C] on the bottom support block so that there's equal overhang on both ends. Secure it with two 3-inch construction screws driven through the footrest and into the bottom support block [D].
- 4. Flip the stilt over and position the side support blocks [B] against it, centered on the footrest. Drive one 3-inch construction screw through the center of each support block and into the footrest.
- 5. Turn the stilt on its side and use a 6-inch-long, ⅝-inch-diameter drill bit to make a pair of pilot holes through the side support blocks [B] and into the body of the stilt [A]. Drive a ¼ x 5-inch lag screw into each pilot hole.
- 6. With a sander (or a square of sandpaper), use 80-grit followed by 120-grit to carefully sand the stilts where the user's hands will grip. If there are any sharp corners on the tops of the support blocks or footrests, reduce them with the 80-grit paper.



STILTS!

A project to build with your children.

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BERENDSOHN

Difficulty:

EASY | REASONABLE | HARD



Time: 30 minutes | Ages: 8+

PROJECT NOTES

THE KEY TO THIS PROJECT is a sturdy design that's fast and simple to build. We were disappointed by our first few attempts to fasten the footrest. A $\frac{1}{16}$ -inch heavy steel bracket bent the moment we put any weight on it. Bolts and screws were stronger, but they either gave off disturbing creaking noises or loosened as we walked on them. It wasn't until we got to the current design, which has no through holes to drill or angled support brackets to cut, that we were satisfied with the footrests.

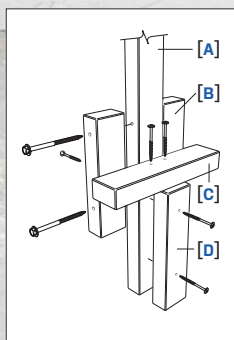
In terms of height, our first try was only 6 inches off the ground. We wanted to get stability and build under control before we worried about height. After that, we went up to 12 inches. Depending on the height of the child, you could go somewhat higher than that, but for safety, it's best not to go any higher than the child's knee. He'll need to step up to it without help, after all.

We wondered if we would need some sort of tread on the bottom of the stilts, but after walking a slick garage floor, a concrete sidewalk, and a lawn, we found that traction was not a problem. After only a few minutes of wear, the feet of the stilts roughened up enough to provide grip on most surfaces.

One issue we didn't expect was splinters. Construction lumber has to be carefully sanded where the stilt user puts his or her hands and where the body of the stilts rubs against the person's arms. Fortunately,

a random orbital sander or even just hand sanding quickly takes care of the problem. While you're at it, knock off any sharp corners on the footrests or support blocks.

We had a 180-pound man walk around on these, so they should be more than capable of handling most children.



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Jim Cantore

Meteorologist and Storm Tracker
The Weather Channel

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